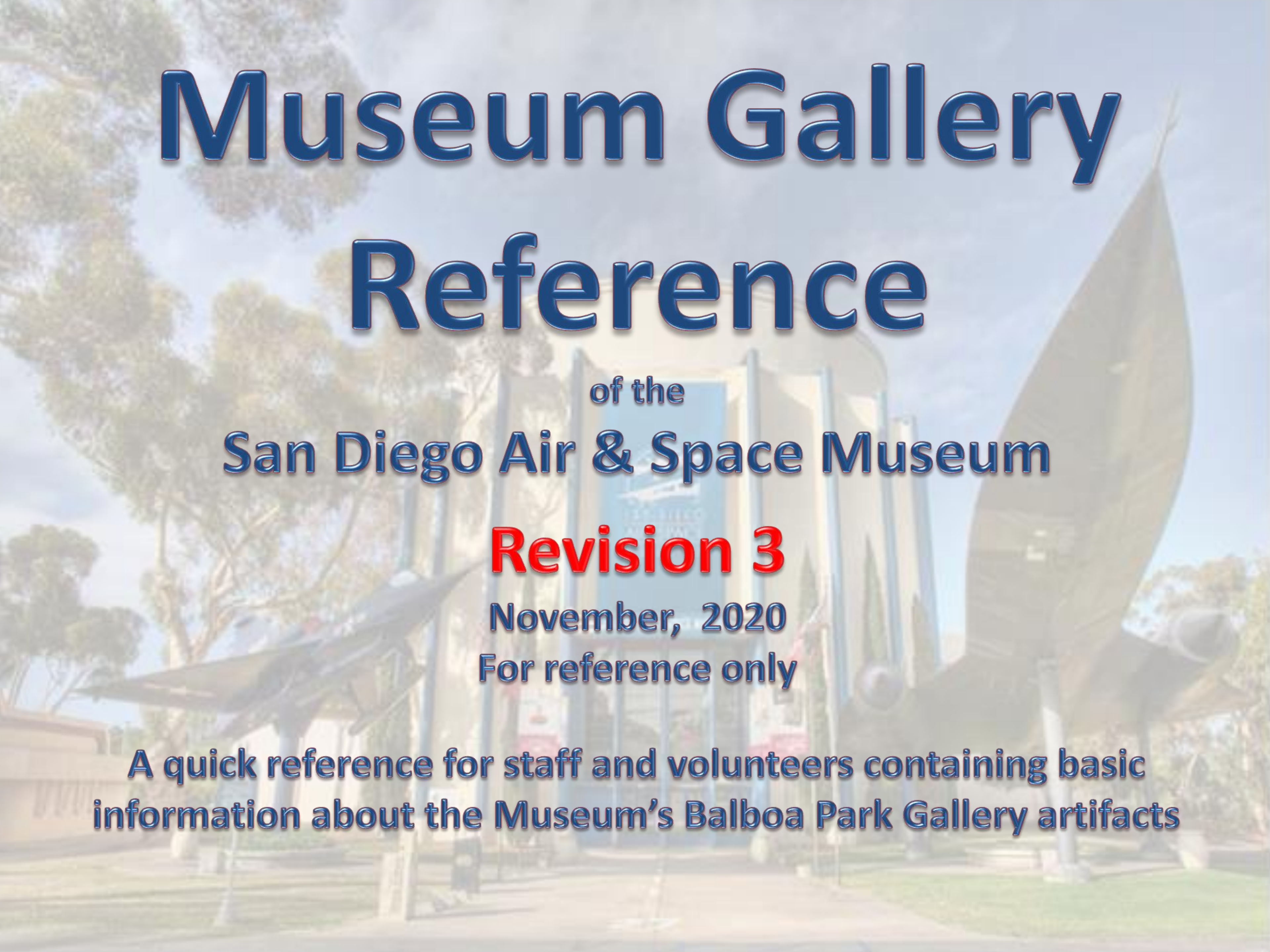

Museum Gallery Reference

of the

San Diego Air & Space Museum

Revision 3

November, 2020

For reference only

A quick reference for staff and volunteers containing basic information about the Museum’s Balboa Park Gallery artifacts

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Purpose of the Museum Gallery Reference

This Museum Gallery Reference is designed to be a quick reference for Museum staff, volunteers and docents. It is an accumulation of facts found in several different information sources. It is organized to provide the reader a single document with which to view basic information about the museum's artifacts.

There is no attempt to provide extensive detailed information about each artifact. Rather, the Museum Gallery Reference attempts to provide sufficient information to the reader so they may inform and entertain museum guests with interesting information to inspire, educate and celebrate aviation/space flight history and technology. Personal reading and research into additional technical and historical aviation/space information is encouraged.

The SDASM artifacts are mostly organized chronologically in gallery's. This Reference follows the chronlogical sequences as a person might walk through the Museum on a tour.

The pages of the Museum Gallery Reference are laid out to show a first page with a PICTURE of the museum's artifact, along with some KEY POINTS text about the artifact. On the second page is a picture of the artifact's STORY BOARD (if there is one) and occasionally EXTRA INFO about the artifact.

The 'Key Points' and 'Extra Info' text included on these pages are from: Artifact 'story boards', SDASM Commercial Guidebook, SDASM Docent Training Guide, SDASM Website, the Smithsonian Website and footnoted websites.

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INTRODUCTION

Paper Version - The colored top bar on each page is to assist in finding a gallery section (Rotunda, Space, WWI, Golden Age, etc.) in the Museum Gallery Reference quickly. The colors are duplicated in the paper copy of the Museum Gallery Reference Table of Contents (TOC).

Electronic version - has an interactive TOC. By touching or clicking on an artifact's name in the TOC, you will be taken to the artifacts page. To return to the TOC, touch or click on the "Back to TOC" link at the bottom right corner of each page.

There are several categories of artifacts exhibited in the Museum:

1. **Originals** were produced by the original manufacturers (e.g. Deperdussin and Supermarine Spitfire).
2. **Replicas** are vehicles built where the original was built, by at least some of the people who participated in building the original. All of the major internal and external features of the craft are faithfully duplicated in a replica (e.g. Spirit of St Louis).
3. **Reproductions** also duplicate internal and external features, and often are as accurate and important as replicas, but aren't necessarily built where the original was, or by any original craftsmen.
4. **Mock-ups** are only accurate enough to provide the viewer with the size, shape, colors, and major external features of the original (e.g. Mercury capsule and X-1).
5. **Models** are similar to mock-ups, but are often built in a different scale than the original (e.g.Global Hawk and Montgolfier Balloon). Non-originals are used in the Museum to illustrate significant aircraft when originals don't exist, were unaffordable, or would not fit in the galleries (e.g. B-17 and B-24).

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Museum Mission
And History

Museum Mission

SAN DIEGO AIR&SPACE MUSEUM
SAN DIEGO AIR & SPACE MUSEUM

Key Points:

1961 - Museum established.
1963 - Museum opened (Feb 15) to the public.
Second largest aerospace library and archives in the nation.
1986 - First aero-themed museum accredited by American Association of Museums.
2006 - Awarded Smithsonian Affiliate status.
2007 - Designated the Official Air & Space Museum and Education Center of California (State Legislature).

The **San Diego Air & Space Museum** serves the public through its **mission** to:

Preserve… Inspire… Educate… Celebrate!

Preserve significant artifacts of air and space history and technology.

Inspire excellence in science, technology, engineering and mathematics.

Educate the public about the historical and social significance of air and space technology and engage its promise for the future.

Celebrate aviation and space flight history and technology.

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Museum History

300,000+ museum guests in 2019

Ford Building (constructed for the **California Pacific International Exposition** in 1935 and put on the **National Register of Historic Places** in 1973. Historical Note: The interior of the Ford building features a **468 x 18 foot** mural titled the ***March of Transportation***, painted by Hollywood scenic artist Juan Larrinaga and restored by Thomas Emery. The mural is acknowledged as one of the largest in the United States.

Key Points:

October 12, 1961, Incorporated as San Diego Aerospace Museum by State of California.

February 15, 1963, Opened doors in the Food and Beverage Building.

March 15, 1964, the International Aerospace Hall of Fame (IAHF), was established.

February 22, 1978, Electric Building and most contents destroyed by fire. **All** the aircraft, the IAHF, artifacts and archival collections were consumed. Some materials were salvaged (Photos, documents, aircraft frames, medals).

February 22, 1980, New museum opened in the Ford Building w/25 aircraft, second replica of the Spirit of St. Louis.

1983, Museum annex was opened at Gillespie Field.

April, 1993, the International Aerospace Hall of Fame merged with the Museum.

2006, acquired **Low Speed Wind Tunnel** at Lindbergh Field.

2006, Museum changed name to the ***San Diego Air & Space Museum***. *International Aerospace Hall of Fame* became the ***International Air & Space Hall of Fame***.

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SDASM By the Numbers (2019)

ATTENDANCE

- **280,000+** Total Admissions
- **74,000+** Free Admissions (Tuesdays, Dec Nights, school groups & military)

EDUCATIONAL PROGRAMMING

- Education department enriched the lives of **22,611** students
- Museum's 41 education events drew **23,089** participants
- **112** different schools visited the Museum

STAFF AND VOLUNTEERS

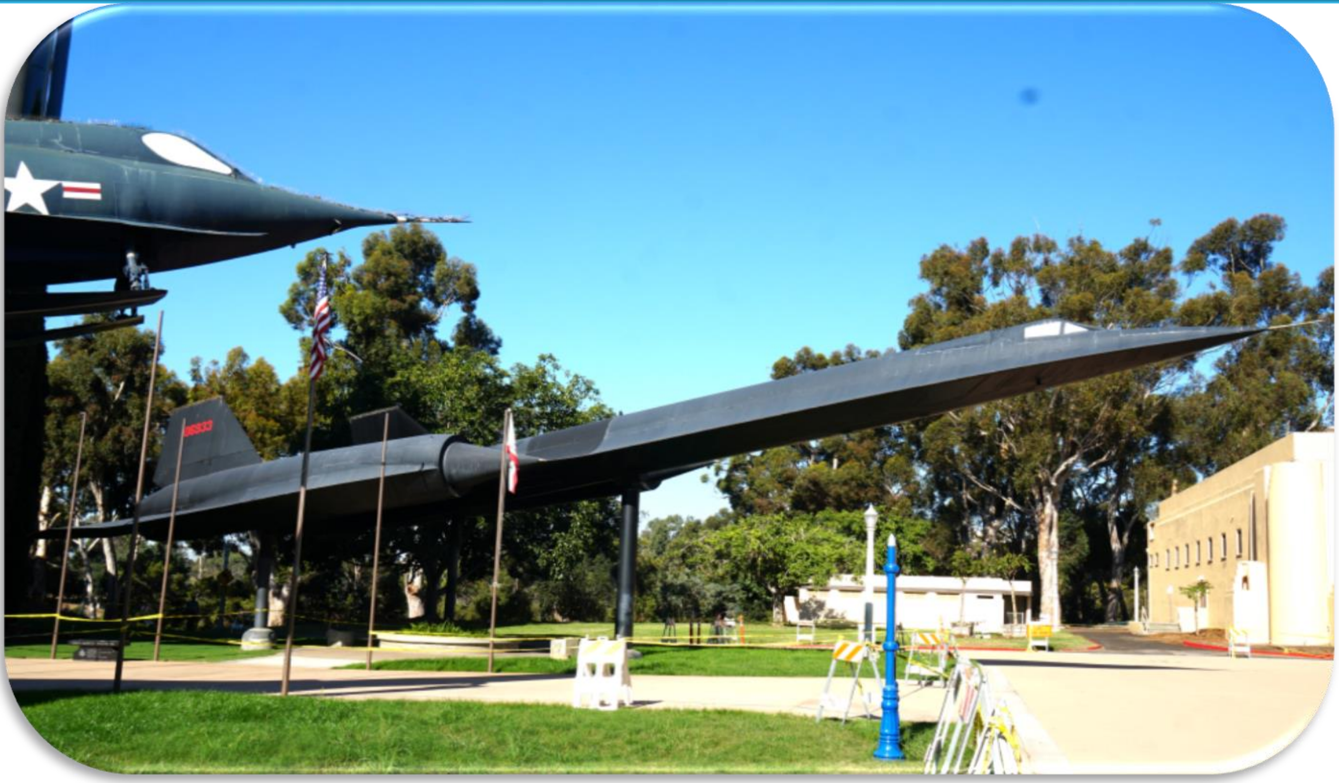
- **75** paid staff including full-time, part-time and on-call positions
- A dedicated volunteer workforce of **129**
- Volunteers provided **30,000+** hours of service

ONLINE & SOCIAL MEDIA

- Museum's website received **729,805** views
- Website sessions/Visits: 268,388
- Website Unique Visitors: 215,566
- **40+ million** views of the Museum's digital images and films offered online
- More than **900** films added to the Museum's YouTube channel
- **1.6 million** views of the Museum's films on YouTube
- YouTube – Library & Archives, **12,500** subscribers
- Flickr – Library & Archives, more than **8,500** Followers
- Facebook: **19,000** Followers
- Twitter: **6,087** Followers
- Instagram: **1,912** Followers

Museum Entrance Gallery

Museum Entrance Gallery



1st Flight:
1962
(47 built)

Quick ID
A-12 has **1** pilot **side** window.
SR-71 has **2** pilot **side** windows.

Key Points: **A – 12 Blackbird (Original)** Contracted by CIA, built by Lockheed's "Skunk Works", Burbank, CA. Often confused w/USAF SR-71. Still the fastest aircraft (air breathing) in the world (Mach 3+ at 85,000 ft.). **First flight Apr 1962**. Aircraft is 93% titanium to resist 600° to 900° heat in flight. Two P&W J-58 turbo-ram jet engines. Carries 84k of JP-7 fuel. Can photo survey an area **30 miles wide, coast to coast in about 1 Hr.**

This: **10th A-12 built** for about **$8 million** (Later SR-71's cost about $33 million). In service Nov **1963** to Aug **1965**, **217 Missions**, **406 hours**. Serial #: 60-6933 (Manufacturer aircraft #130), retired **1969**, public display, Jun 1991.

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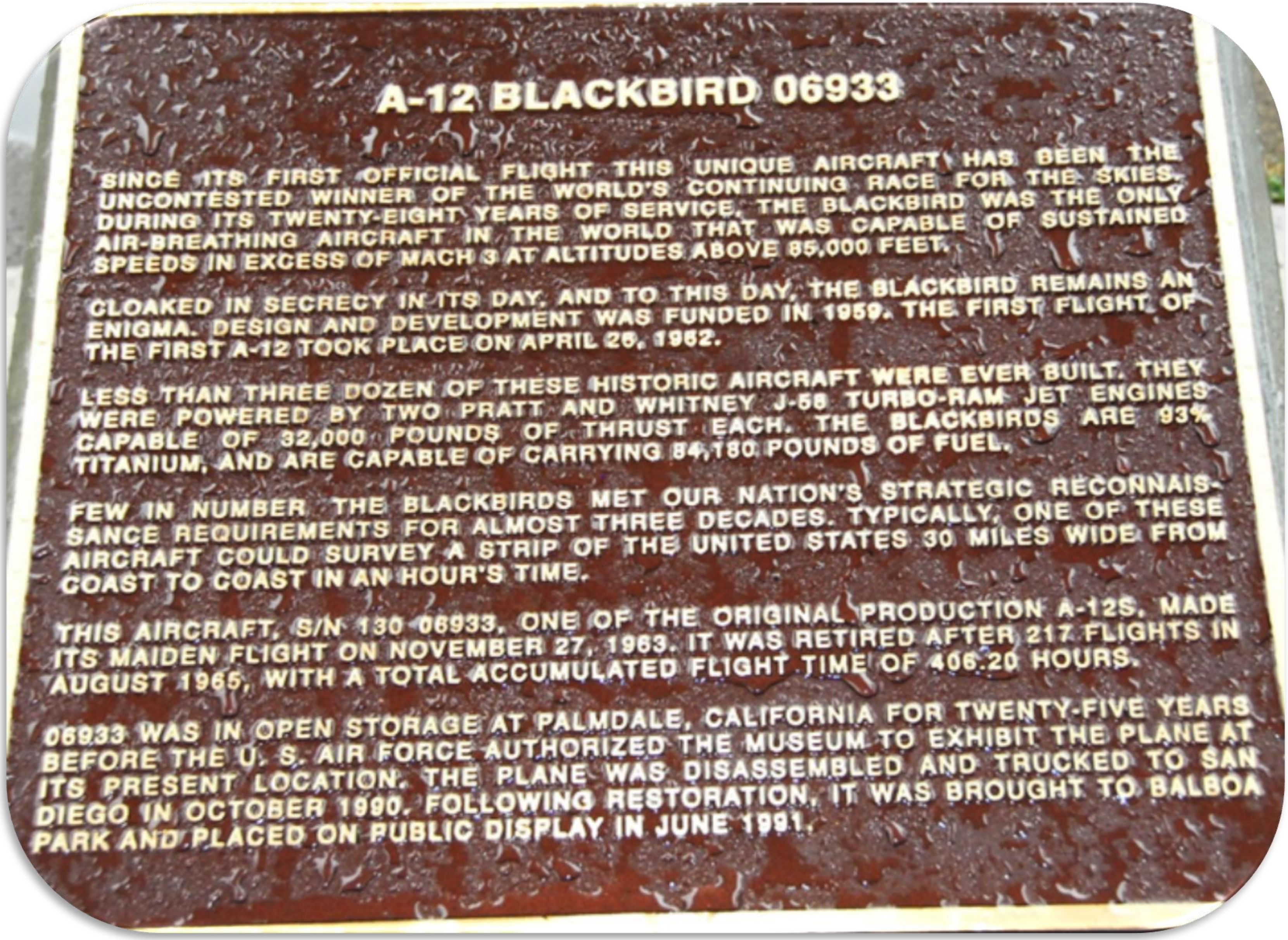
Museum Entrance Gallery



A-12 BLACKBIRD 06933

SINCE ITS FIRST OFFICIAL FLIGHT THIS UNIQUE AIRCRAFT HAS BEEN THE UNCONTESTED WINNER OF THE WORLD'S CONTINUING RACE FOR THE SKIES. DURING ITS TWENTY-EIGHT YEARS OF SERVICE, THE BLACKBIRD WAS THE ONLY AIR-BREATHING AIRCRAFT IN THE WORLD THAT WAS CAPABLE OF SUSTAINED SPEEDS IN EXCESS OF MACH 3 AT ALTITUDES ABOVE 85,000 FEET.

CLOAKED IN SECRECY IN ITS DAY, AND TO THIS DAY, THE BLACKBIRD REMAINS AN ENIGMA. DESIGN AND DEVELOPMENT WAS FUNDED IN 1959. THE FIRST FLIGHT OF THE FIRST A-12 TOOK PLACE ON APRIL 26, 1962.

LESS THAN THREE DOZEN OF THESE HISTORIC AIRCRAFT WERE EVER BUILT. THEY WERE POWERED BY TWO PRATT AND WHITNEY J-58 TURBO-RAM JET ENGINES CAPABLE OF 32,000 POUNDS OF THRUST EACH. THE BLACKBIRDS ARE 93% TITANIUM, AND ARE CAPABLE OF CARRYING 84,180 POUNDS OF FUEL.

FEW IN NUMBER, THE BLACKBIRDS MET OUR NATION'S STRATEGIC RECONNAISSANCE REQUIREMENTS FOR ALMOST THREE DECADES. TYPICALLY, ONE OF THESE AIRCRAFT COULD SURVEY A STRIP OF THE UNITED STATES 30 MILES WIDE FROM COAST TO COAST IN AN HOUR'S TIME.

THIS AIRCRAFT, S/N 130 06933, ONE OF THE ORIGINAL PRODUCTION A-12S, MADE ITS MAIDEN FLIGHT ON NOVEMBER 27, 1963. IT WAS RETIRED AFTER 217 FLIGHTS IN AUGUST 1965, WITH A TOTAL ACCUMULATED FLIGHT TIME OF 406.20 HOURS.

06933 WAS IN OPEN STORAGE AT PALMDALE, CALIFORNIA FOR TWENTY-FIVE YEARS BEFORE THE U. S. AIR FORCE AUTHORIZED THE MUSEUM TO EXHIBIT THE PLANE AT ITS PRESENT LOCATION. THE PLANE WAS DISASSEMBLED AND TRUCKED TO SAN DIEGO IN OCTOBER 1990. FOLLOWING RESTORATION, IT WAS BROUGHT TO BALBOA PARK AND PLACED ON PUBLIC DISPLAY IN JUNE 1991.

Back to TOC

Museum Entrance Gallery

Extra Info: **A-12/SR-71 Blackbird**

Max (Official) Speed: 2,115 mph

Wings and fuselage temperature between 600-900°F, in normal operation at Mach 3.2, from air friction. Alunimum melts @ 1200° F, hence titanium used which melts @ 3040°F.

CIA formed fake companies to order titanium from Russia (Russia had the most titanium mines).

Special fuel used only in A-12/SR-71 was JP-7. JP-7 flash point so high that TEB* was needed to ignite the JP7. You could throw a lit match into a bucket of JP-7 and the match would go out.
*TEB Triethylborane, was used to start J-58 due to high flash point of JP-7. Each engine had sufficient TEB for 16 start attempts.

Normal mission:
Cruise altitude: 75k to 85k+ feet.
Cruise speed: Mach 3.0 to 3.2.
Mission length: About 90 minutes.
Mission distance: About 3000 miles, roughly from the U.S. East coast to the West coast.

Turning radius @ cruise; 86 to 100 miles.

Crews wore protective pressurized suits, forerunner of space suits.

At cruise, Blackbirds are 6.5 to 8.5” (reports vary) longer and 3 to 5” wider due to heating from air friction.

A-12 is 5 feet shorter than SR-71. The SR-71 needed the extra room for the navigator seat behind the pilot.

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Extra Info: A-12/SR-71 Blackbird

Below Mach 1, turbojet engine provided 100% thrust. At cruise, Mach 3.2, turbojet engine provided 17% thrust, afterburner (similar to a ramjet) provided 83% thrust.

Engine inlet cones moved fore/aft 26" to control shock wave outside of inlet and allow subsonic airflow into engine.

The A-12 fleet (CIA) had 12 operational + 1 trainer & 2 drone launchers.

The SR-71 fleet (USAF) had 29 operational, 2 test beds, 1 trainer. 47 Blackbirds total.

11 or 12, Blackbirds lost thru accidents. 2 pilot and 1 navigator deaths or just 1 navigator death (reports vary).

Over 800 missiles fired at Blackbirds, ∅ (zero) connected.

On Mar 6, 1990, SR-71, #972, flew from **Palmdale, CA** to **Washington-Dulles** (for display in the Smithsonian) in **1 hour, 4 minutes and 20 seconds**, **setting three speed records** in the process (West coast to East coast; LA to Washington DC; St Louis to Cincinati). Average speed: **2124 or 2145 mph** (reports vary).

Blackbird fleet retired 1989, a few reactivated, retired again 1998.

Last Blackbird flight Oct 9, 1999, over Edwards AFB hit Mach 3.2 at 80,100 feet (2430 mph!).

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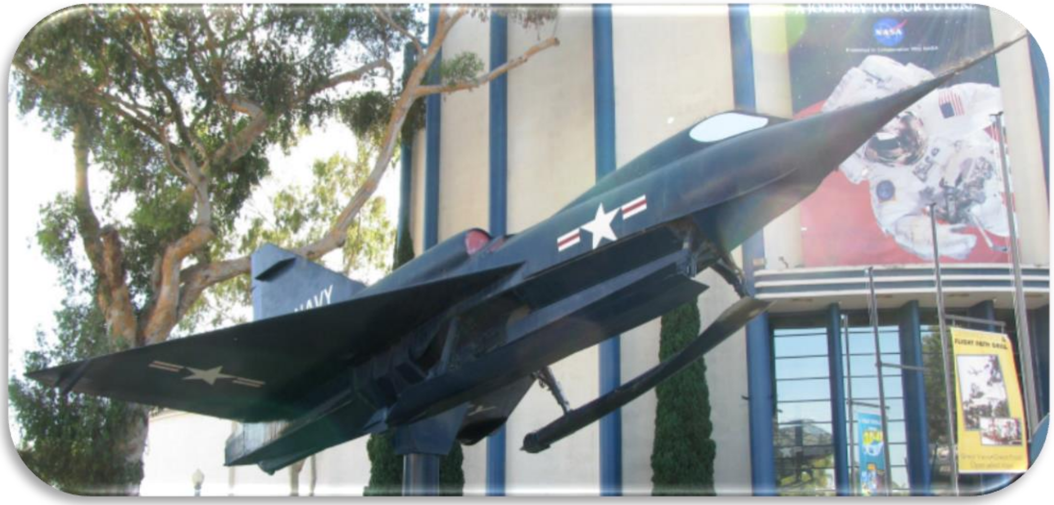
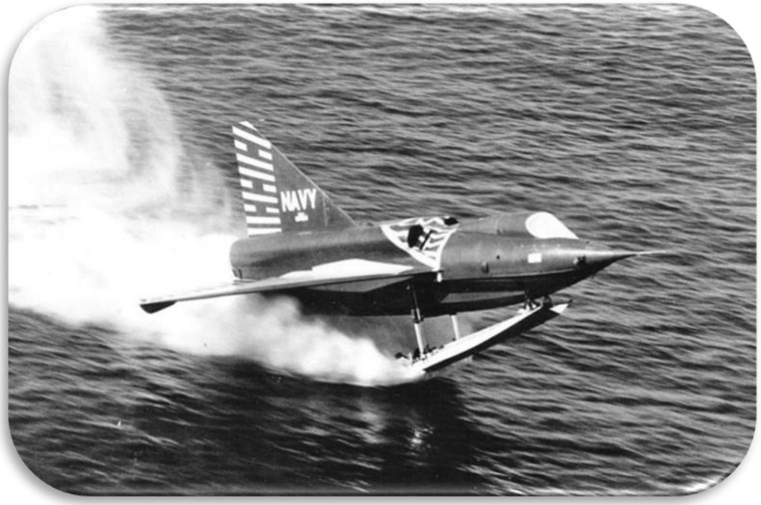
Museum Entrance Gallery





1st Flight: 1953 (5 built)

Key Points: Convair YF2Y-1 Sea Dart (Original) Experimental supersonic seaplane. Built by Convair, in San Diego. 5 built, 3 flown, 1 crash. First flown Apr, **1953**, final test flight in 1956, program cancelled 1957. Speed: 825 MPH, **first delta wing seaplane and only seaplane to have exceeded the speed of sound**. Most test flights conducted on San Diego Bay and off coast from San Diego beaches. The one crash was into the Bay in front of spectators, likely an overstressing of the Sea Dart in hopes of impressing the crowd.

This: The Museum's Sea Dart was the third produced by Convair. Serial Number: 135763. First flew on March 4, **1955**. Donated by Convair in 1963.

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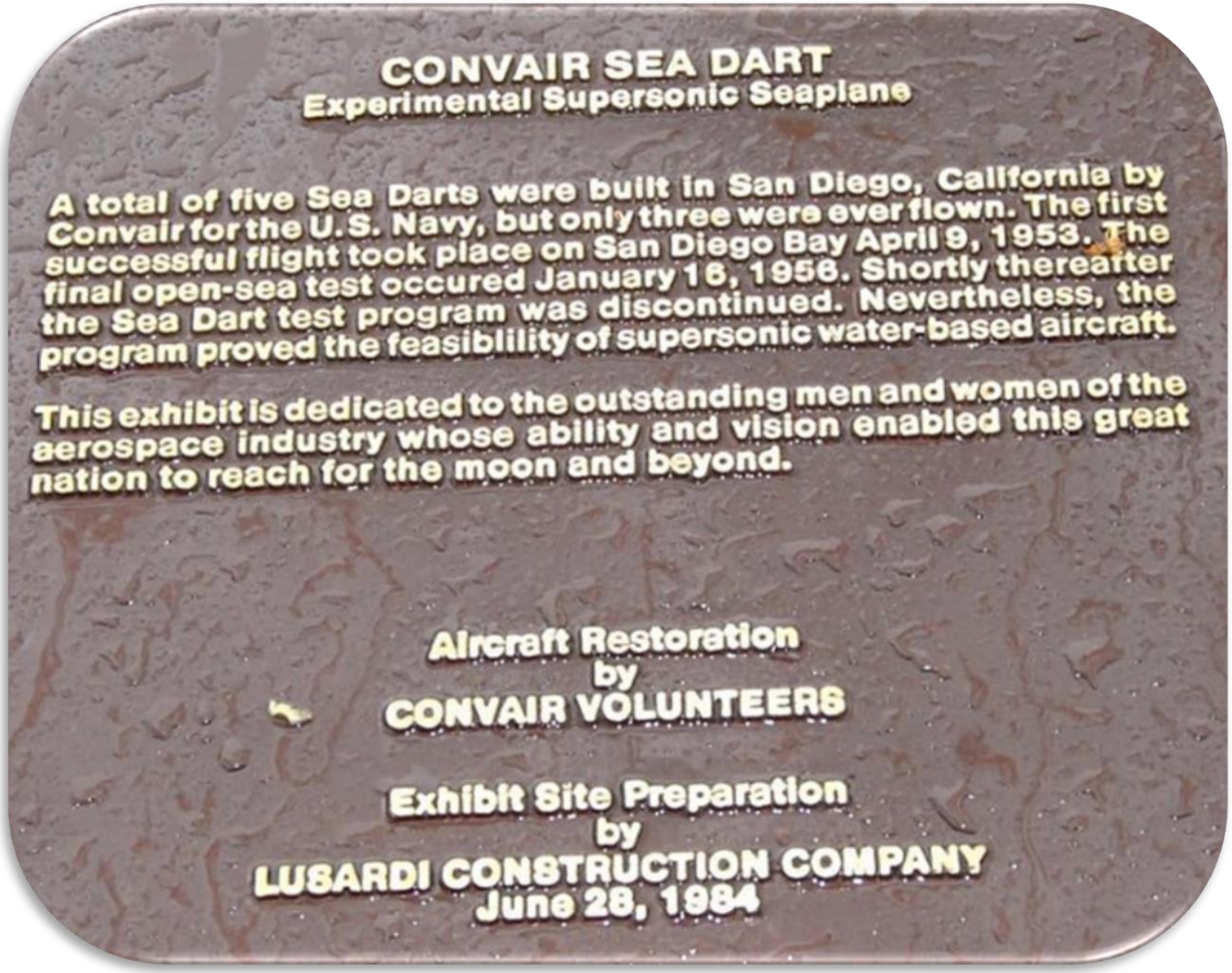
Museum Entrance Gallery

Extra Info: YF2Y-1 Sea Dart
1950s, the Navy investigated the idea of **a supersonic, water-based fighter to operate in sheltered water areas around the world**. Explored single or dual retractable hydro-skis; single ski configuration proved more successful. First flight (over San Diego Bay) on **April 9, 1953.** August, 1954, first supersonic flight. In 1956, tactical doctrine changed, Navy abandoned the seaplane fighter concept.
The Sea Dart floated on the water. It had **watertight compartments in the lower fuselage to prevent sinking**. A set of **dive brakes on the lower rear fuselage doubled as water brakes and as a water rudder while taxiing on the surface**. For takeoff, the skis were initially retracted and then extended as the aircraft accelerated to a **takeoff speed of about 145 mph**.



CONVAIR SEA DART
Experimental Supersonic Seaplane

A total of five Sea Darts were built in San Diego, California by Convair for the U.S. Navy, but only three were ever flown. The first successful flight took place on San Diego Bay April 9, 1953. The final open-sea test occured January 16, 1956. Shortly thereafter the Sea Dart test program was discontinued. Nevertheless, the program proved the feasibility of supersonic water-based aircraft.

This exhibit is dedicated to the outstanding men and women of the aerospace industry whose ability and vision enabled this great nation to reach for the moon and beyond.

Aircraft Restoration
by
CONVAIR VOLUNTEERS

Exhibit Site Preparation
by
LUSARDI CONSTRUCTION COMPANY
June 28, 1984

TECHNICAL DATA
MANUFACTURER: Consolidated Aircraft Corporation, San Diego, CA
POWERPLANT: Two Westinghouse J46 afterburning turbojet engines.
SPAN: 33 ft 8 in; Length: 52 ft 7 in; HEIGHT: 16 ft 2 in
WEIGHT: Empty 15,900 lbs (gross, 21,200 lbs)
MAX SPEED: 825 mph

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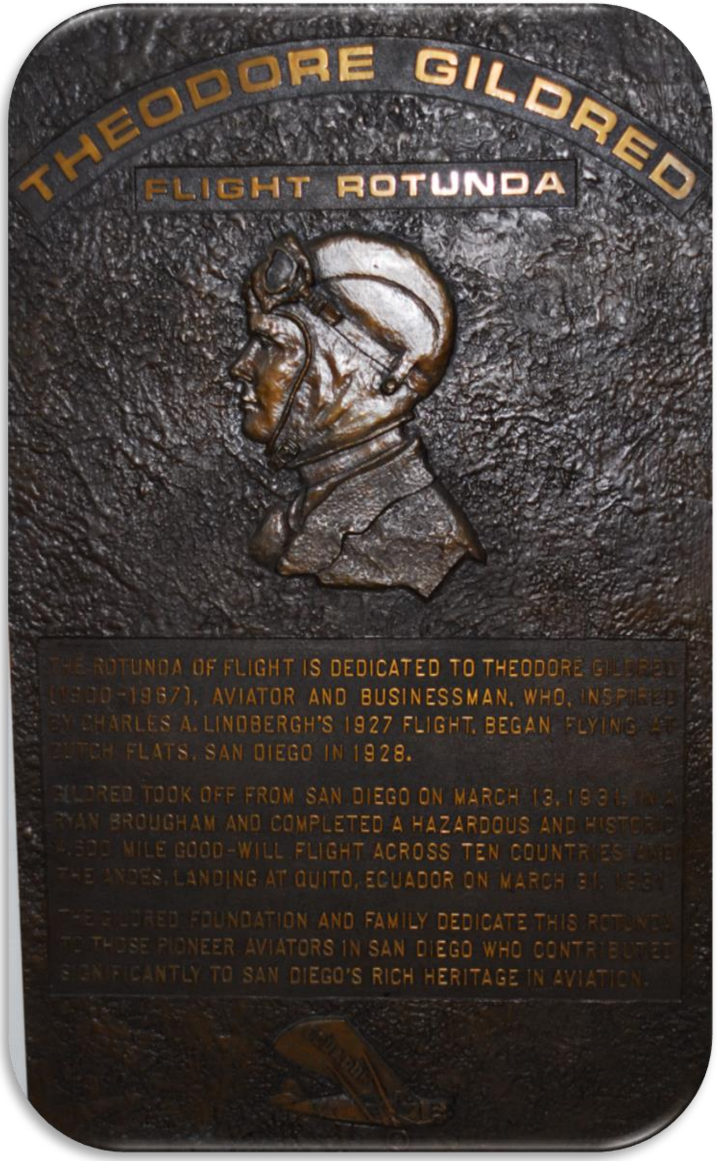
Rotunda Gallery

Theodore Gildred Flight Rotunda

Key Points: San Diegan **Theodore** Gildred, Sr. took off from **San Diego** on **March 13, 1931**, in a **Ryan B-5 Brougham**, beginning a **13-day, 4600 mile goodwill flight across 10 countries** and the Andes to land at **Quito, Ecuador**, South America.

Extra Info: 50 years later, Gildred's son, Theodore Gildred, Jr., recreated his father's famous flight, using a 1943 Stinson Reliant from the Air & Space Museum. After completion of the 1981 commemorative flight, the Museum donated the Stinson to the people of Ecuador to help them establish their own museum.



THE ROTUNDA OF FLIGHT IS DEDICATED TO THEODORE GILDRED (1900-1967), AVIATOR AND BUSINESSMAN, WHO, INSPIRED BY CHARLES A. LINDBERGH'S 1927 FLIGHT, BEGAN FLYING AT DUTCH FLATS, SAN DIEGO IN 1928.

GILDRED TOOK OFF FROM SAN DIEGO ON MARCH 13, 1931, IN A RYAN BROUGHAM AND COMPLETED A HAZARDOUS AND HISTORIC 4,600 MILE GOOD-WILL FLIGHT ACROSS TEN COUNTRIES AND THE ANDES, LANDING AT QUITO, ECUADOR ON MARCH 31, 1931.

THE GILDRED FOUNDATION AND FAMILY DEDICATE THIS ROTUNDA TO THOSE PIONEER AVIATORS IN SAN DIEGO WHO CONTRIBUTED SIGNIFICANTLY TO SAN DIEGO'S RICH HERITAGE IN AVIATION.

Back to TOC

Rotunda Gallery

Spirit of St. Louis

Key Points: **Charles Lindbergh & Amelia Earhart** (Animatronics) welcome guests to the SDASM. A life-like animatronic of Lindbergh stands under the wing of the "Spirit of St. Louis" in the Theodore Gildred Rotunda and a life-like animatronic of Earhart stands near her Lockheed Vega in the Museum's Golden Age of Flight Gallery. Both world famous aviators greet guests with brief's of their accomplishments and share with visitors the adventure and history of air and space exploration they will experience during their trip through the Museum.

This: The animatronics' were created by LifeFormations, an art and fabrication studio. They are the first quality animatronics in Balboa Park.

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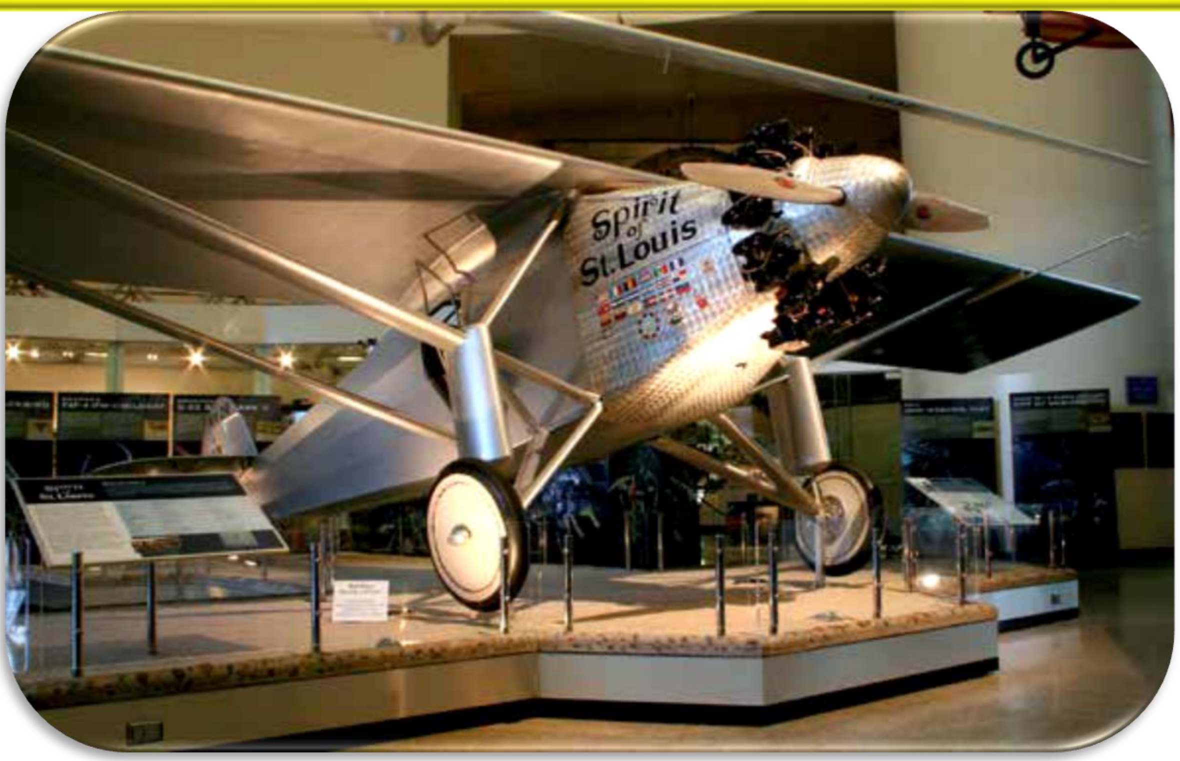
Rotunda Gallery



1st Flight:
1927

Key Points: Spirit of St. Louis (Replica). May 20/21, 1927, non-stop New York-to-Paris (**3600 mi**) in **33 hours, 30 min**. Designed, built and tested by **Ryan Aircraft in San Diego** for the $25,000 **Orteig Prize**. Based on Ryan M-2 aircraft, built in 60 days, for just over $10,000. Engine: 223 hp 9 cylinder Wright J-5-C Whirlwind radial. 450 gallons of fuel. No radio, unstable tail, wicker seat. After Paris, flew to Belgium & England. Then the US Navy carried Spirit to USA, where it flew across the United States and Latin America. Final flight was on April 30, 1928, to Smithsonian, Washington DC.

This: Is the 2nd replica (1st was destroyed in 1978 Museum fire), built & **flew** in **1979** (test flights) and **flew** in **2003** for the 75th Anniversary Lindberg Field.

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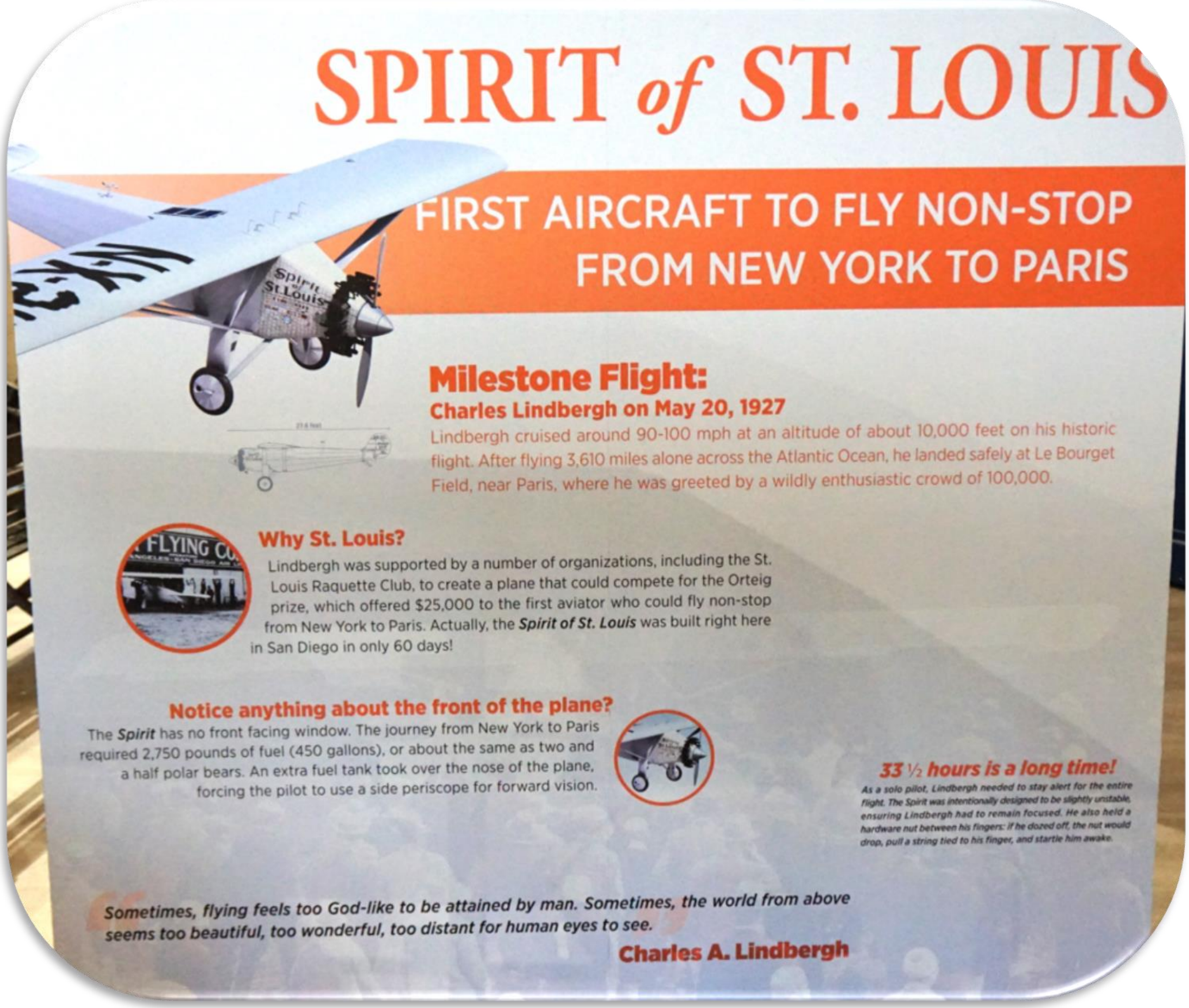
Rotunda Gallery



SPIRIT of ST. LOUIS

FIRST AIRCRAFT TO FLY NON-STOP FROM NEW YORK TO PARIS

Spirit of St. Louis

Milestone Flight:

Charles Lindbergh on May 20, 1927

Lindbergh cruised around 90-100 mph at an altitude of about 10,000 feet on his historic flight. After flying 3,610 miles alone across the Atlantic Ocean, he landed safely at Le Bourget Field, near Paris, where he was greeted by a wildly enthusiastic crowd of 100,000.

Why St. Louis?

Lindbergh was supported by a number of organizations, including the St. Louis Raquette Club, to create a plane that could compete for the Orteig prize, which offered $25,000 to the first aviator who could fly non-stop from New York to Paris. Actually, the ***Spirit of St. Louis*** was built right here in San Diego in only 60 days!

Notice anything about the front of the plane?

The ***Spirit*** has no front facing window. The journey from New York to Paris required 2,750 pounds of fuel (450 gallons), or about the same as two and a half polar bears. An extra fuel tank took over the nose of the plane, forcing the pilot to use a side periscope for forward vision.

33 ½ hours is a long time!

As a solo pilot, Lindbergh needed to stay alert for the entire flight. The Spirit was intentionally designed to be slightly unstable, ensuring Lindbergh had to remain focused. He also held a hardware nut between his fingers: if he dozed off, the nut would drop, pull a string tied to his finger, and startle him awake.

> *Sometimes, flying feels too God-like to be attained by man. Sometimes, the world from above seems too beautiful, too wonderful, too distant for human eyes to see.*
>
> **Charles A. Lindbergh**

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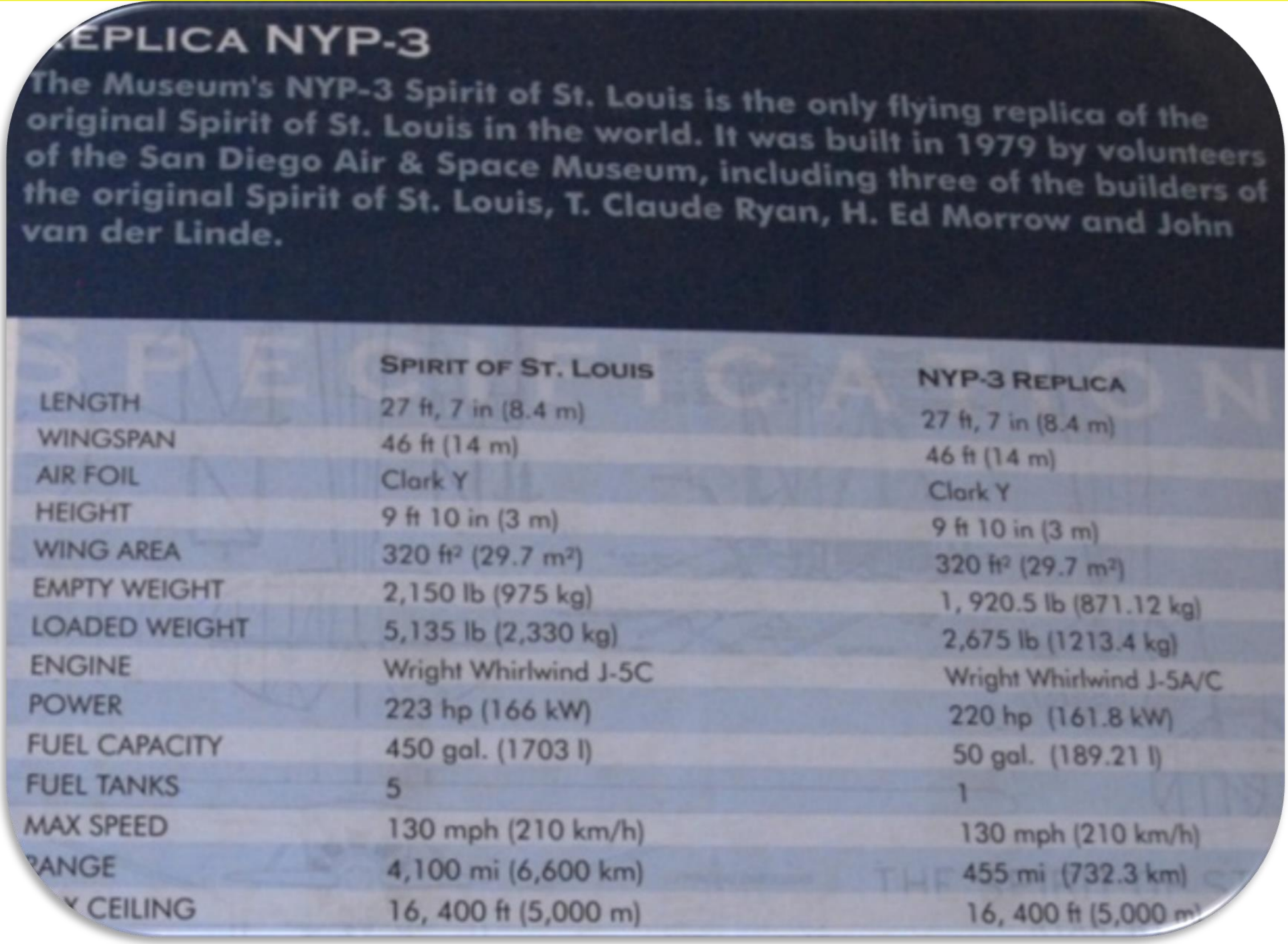
Rotunda Gallery



EPLICA NYP-3

The Museum's NYP-3 Spirit of St. Louis is the only flying replica of the original Spirit of St. Louis in the world. It was built in 1979 by volunteers of the San Diego Air & Space Museum, including three of the builders of the original Spirit of St. Louis, T. Claude Ryan, H. Ed Morrow and John van der Linde.

	SPIRIT OF ST. LOUIS	NYP-3 REPLICA
LENGTH	27 ft, 7 in (8.4 m)	27 ft, 7 in (8.4 m)
WINGSPAN	46 ft (14 m)	46 ft (14 m)
AIR FOIL	Clark Y	Clark Y
HEIGHT	9 ft 10 in (3 m)	9 ft 10 in (3 m)
WING AREA	320 ft² (29.7 m²)	320 ft² (29.7 m²)
EMPTY WEIGHT	2,150 lb (975 kg)	1, 920.5 lb (871.12 kg)
LOADED WEIGHT	5,135 lb (2,330 kg)	2,675 lb (1213.4 kg)
ENGINE	Wright Whirlwind J-5C	Wright Whirlwind J-5A/C
POWER	223 hp (166 kW)	220 hp (161.8 kW)
FUEL CAPACITY	450 gal. (1703 l)	50 gal. (189.21 l)
FUEL TANKS	5	1
MAX SPEED	130 mph (210 km/h)	130 mph (210 km/h)
ANGE	4,100 mi (6,600 km)	455 mi (732.3 km)
X CEILING	16, 400 ft (5,000 m)	16, 400 ft (5,000 m

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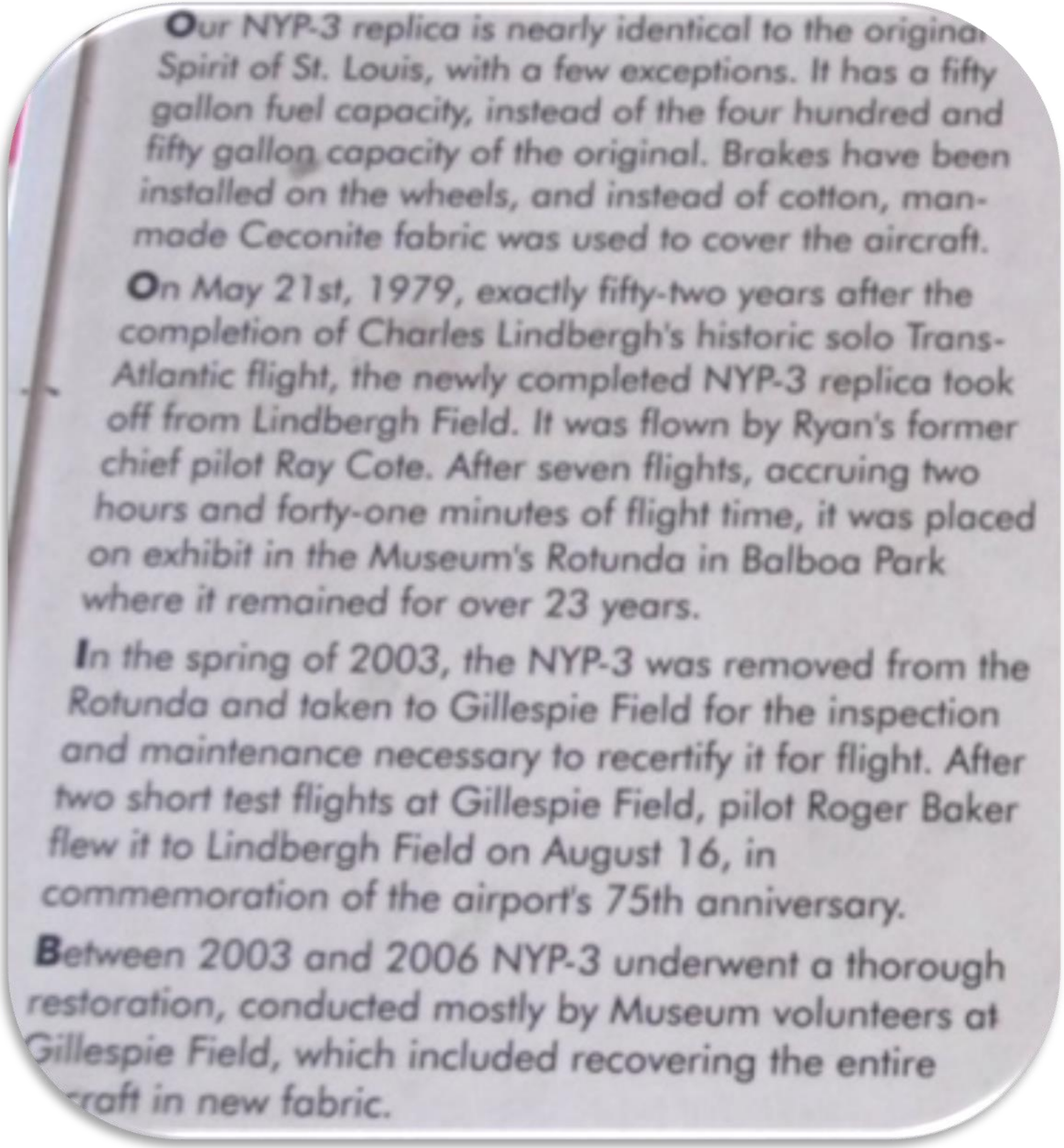
Rotunda Gallery

Spirit
of
St. Louis



Our NYP-3 replica is nearly identical to the origina Spirit of St. Louis, with a few exceptions. It has a fifty gallon fuel capacity, instead of the four hundred and fifty gallon capacity of the original. Brakes have been installed on the wheels, and instead of cotton, man-made Ceconite fabric was used to cover the aircraft.

On May 21st, 1979, exactly fifty-two years after the completion of Charles Lindbergh's historic solo Trans-Atlantic flight, the newly completed NYP-3 replica took off from Lindbergh Field. It was flown by Ryan's former chief pilot Ray Cote. After seven flights, accruing two hours and forty-one minutes of flight time, it was placed on exhibit in the Museum's Rotunda in Balboa Park where it remained for over 23 years.

In the spring of 2003, the NYP-3 was removed from the Rotunda and taken to Gillespie Field for the inspection and maintenance necessary to recertify it for flight. After two short test flights at Gillespie Field, pilot Roger Baker flew it to Lindbergh Field on August 16, in commemoration of the airport's 75th anniversary.

Between 2003 and 2006 NYP-3 underwent a thorough restoration, conducted mostly by Museum volunteers at Gillespie Field, which included recovering the entire raft in new fabric.

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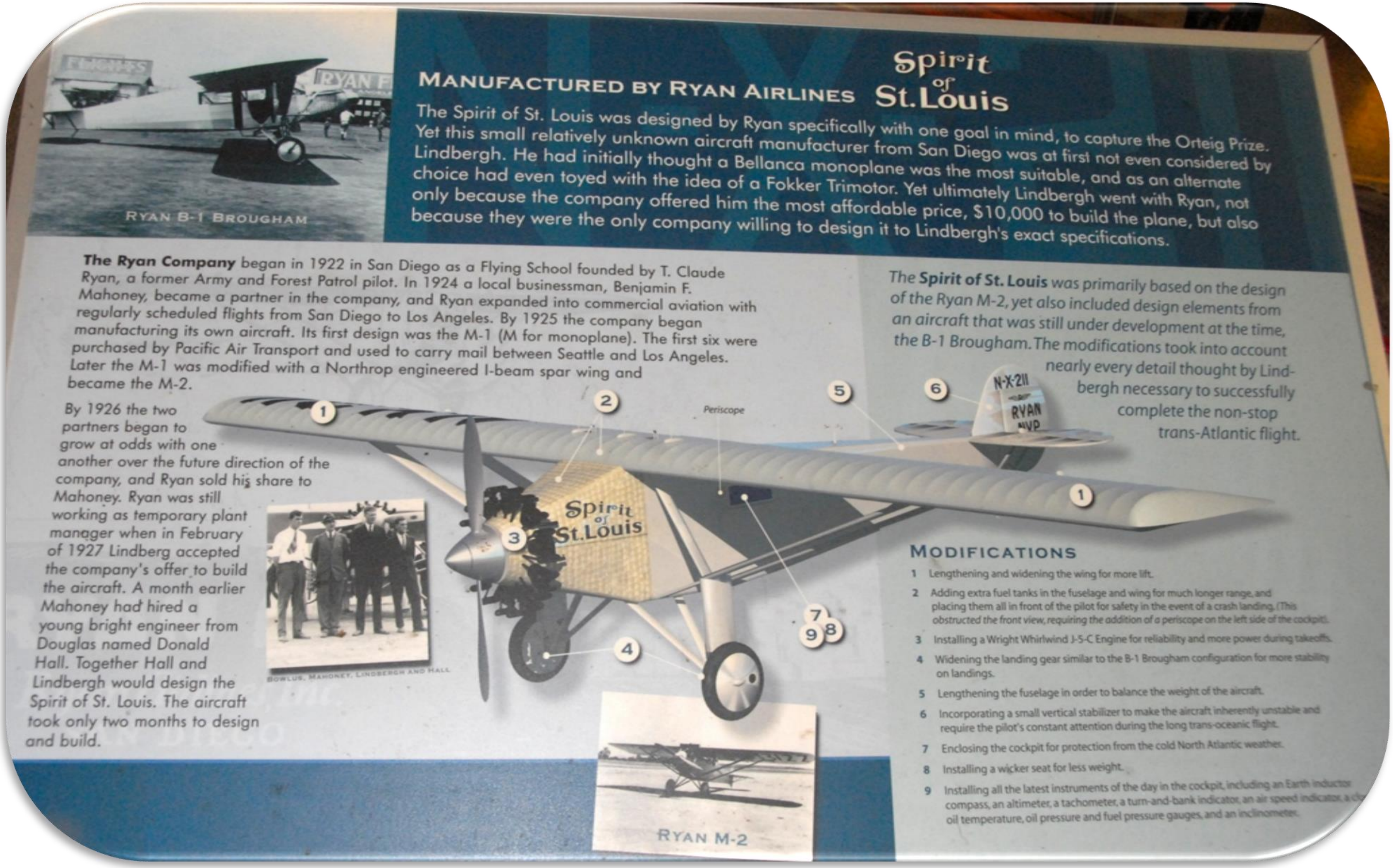
Rotunda Gallery


FLIGHTS
RYAN F
Spirit of St. Louis
N-X-211
RYAN NYP
Periscope
1
2
3
4
5
6
7
8
9

RYAN B-1 BROUGHAM

MANUFACTURED BY RYAN AIRLINES

Spirit of St. Louis

The Spirit of St. Louis was designed by Ryan specifically with one goal in mind, to capture the Orteig Prize. Yet this small relatively unknown aircraft manufacturer from San Diego was at first not even considered by Lindbergh. He had initially thought a Bellanca monoplane was the most suitable, and as an alternate choice had even toyed with the idea of a Fokker Trimotor. Yet ultimately Lindbergh went with Ryan, not only because the company offered him the most affordable price, $10,000 to build the plane, but also because they were the only company willing to design it to Lindbergh's exact specifications.

The Ryan Company began in 1922 in San Diego as a Flying School founded by T. Claude Ryan, a former Army and Forest Patrol pilot. In 1924 a local businessman, Benjamin F. Mahoney, became a partner in the company, and Ryan expanded into commercial aviation with regularly scheduled flights from San Diego to Los Angeles. By 1925 the company began manufacturing its own aircraft. Its first design was the M-1 (M for monoplane). The first six were purchased by Pacific Air Transport and used to carry mail between Seattle and Los Angeles. Later the M-1 was modified with a Northrop engineered I-beam spar wing and became the M-2.

By 1926 the two partners began to grow at odds with one another over the future direction of the company, and Ryan sold his share to Mahoney. Ryan was still working as temporary plant manager when in February of 1927 Lindberg accepted the company's offer to build the aircraft. A month earlier Mahoney had hired a young bright engineer from Douglas named Donald Hall. Together Hall and Lindbergh would design the Spirit of St. Louis. The aircraft took only two months to design and build.

BOWLUS, MAHONEY, LINDBERGH AND HALL

*The **Spirit of St. Louis** was primarily based on the design of the Ryan M-2, yet also included design elements from an aircraft that was still under development at the time, the B-1 Brougham. The modifications took into account nearly every detail thought by Lindbergh necessary to successfully complete the non-stop trans-Atlantic flight.*

RYAN M-2

MODIFICATIONS

1 Lengthening and widening the wing for more lift.

2 Adding extra fuel tanks in the fuselage and wing for much longer range, and placing them all in front of the pilot for safety in the event of a crash landing. (This *obstructed the front view, requiring the addition of a periscope on the left side of the cockpit).*

3 Installing a Wright Whirlwind J-5-C Engine for reliability and more power during takeoffs.

4 Widening the landing gear similar to the B-1 Brougham configuration for more stability on landings.

5 Lengthening the fuselage in order to balance the weight of the aircraft.

6 Incorporating a small vertical stabilizer to make the aircraft inherently unstable and require the pilot's constant attention during the long trans-oceanic flight.

7 Enclosing the cockpit for protection from the cold North Atlantic weather.

8 Installing a wicker seat for less weight.

9 Installing all the latest instruments of the day in the cockpit, including an Earth inductor compass, an altimeter, a tachometer, a turn-and-bank indicator, an air speed indicator, a c oil temperature, oil pressure and fuel pressure gauges, and an inclinometer.

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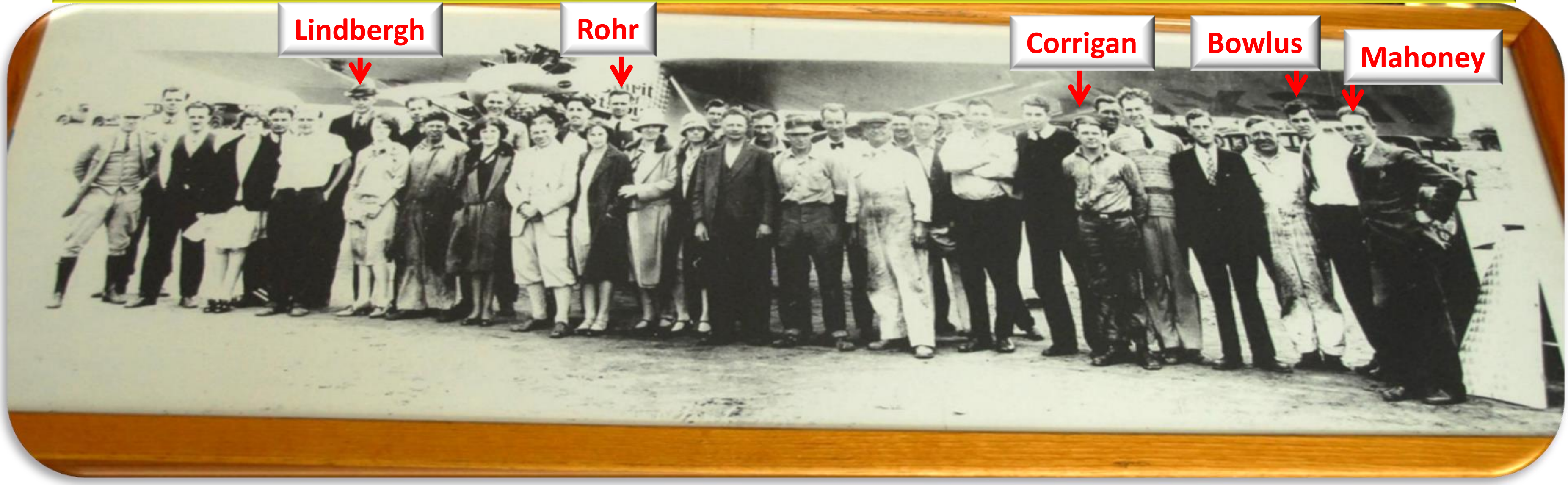

Builders of the original "Spirit of St. Louis" pose before the plane prior to Lindbergh's departure from San Diego in 1927: (left to right) *Gordy L. Boyd, George F. Hammond, Burt Tindale, Jesse Cooper, O.R. McNeel, Walter O. Locke,* ***Charles A. Lindbergh****, Georgia Mathias Borthwick, Lawrence W. Muehleisen, Frank Say, Ed "K" Crosby, June Eddy, A.J. Edwards, Daniel B. Burnett, Jr., Peggy DeWitt,* ***Fred H. Rohr****, Ruth Kennaugh Clemens, Mrs. L. Bray, Shirley Morrison, Bill Van den Akker, Mel (Andy) Anderson, Pat Davenport, Ed Terry, C. Randolph, Elmer Dye, C. Rand, Gus Eoff, Walt A. Crawford, Unknown,* ***Doug Corrigan****, John Van der Linde, Dale Powers, J.J. Red Harrigan,* ***William Hawley Bowlus*** *and* ***Frank Mahoney****.* **Other "Spirit of St. Louis" builders not shown in photo:** *Donald Hall, Henry Hunold, Ed Sherburn,* ***Ed Morrow****, Ed Krauscyk, B. Jones, Fred Magula, Fred Ayres, Doug Kelley, William Bodie, Lon Wheeler, John Lester, John Stoner, Jimmy Erickson, Albert C. Crygier, Helen Thorpe, Charlie Miller and Charlie Hansen.*

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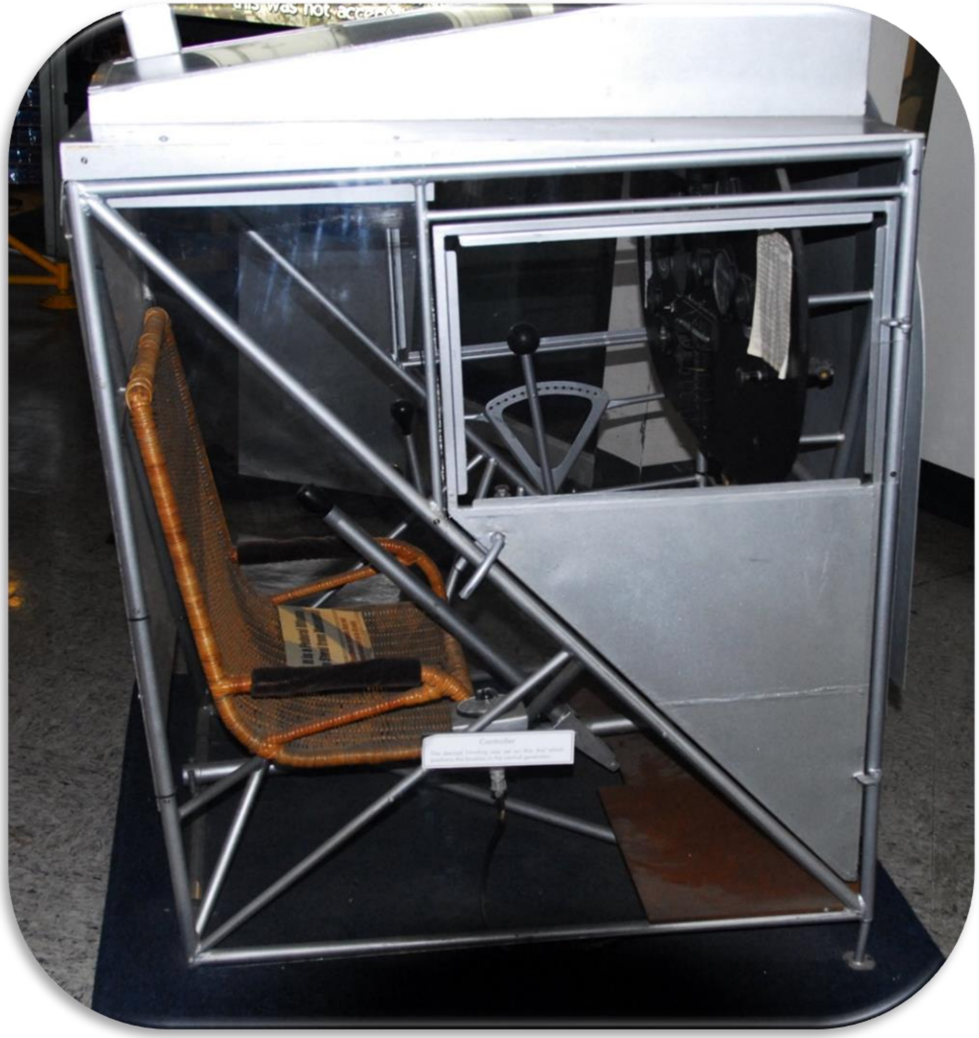

Full scale reproduction of Spirit of St Louis cockpit. Note wicker seat, used so that Lindbergh would not be too comfortable and fall asleep. Charles Lindberg reportedly sat in this reproduction and described the operation of the fuel feed controls.

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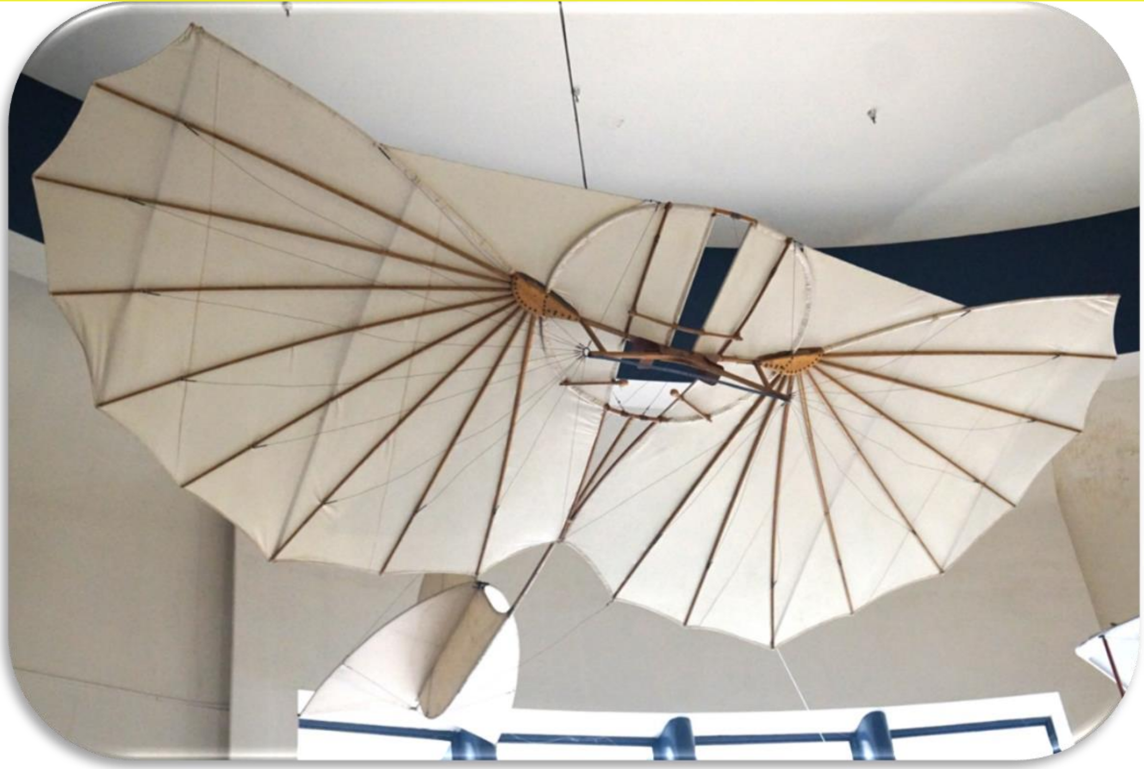

1st flight: 1891

Key Points: **Lilienthal Glider** (Reproduction). German engineer **Otto Lilienthal** (1848 – 1896) studied aerodynamics then built a glider that would fly and be controlled. Wrote the book ***Birdflight as the Basis of Aviation*** in 1889. This **text was used by the Wright brothers**. **Lilienthal considered the first pilot because he could control (fly) the glider by shifting his body weight.** Over **2,000 flights** between 1891 and his death in a crash in 1896.

This: Modeled after glider #11 from 1896, built by John Lichtenburg, from Lilienthal's original drawings, weighed 40 lbs. This glider was completed in 1978.

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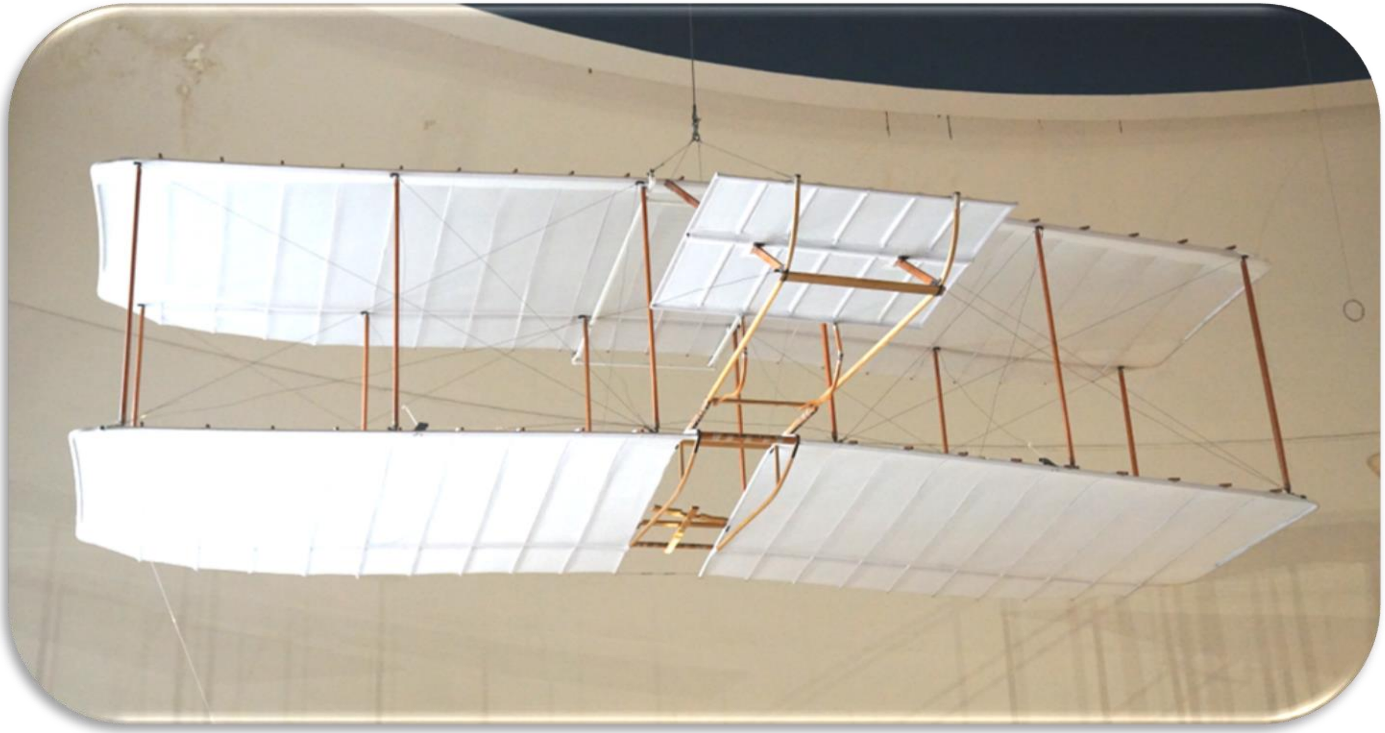

1^{st} flight: 1901

Key Points: **1901 Wright Glider** (Reproduction). The **second of the Wright gliders** was built in **1901**; based heavily on Lilienthal concepts. **Used an elevator and wing warping** for control. **Difficult to control, poor lifting characteristics,** but good for practice. **Wright's built their own wind tunnel to improve design**. First tested at Kitty Hawk, North Carolina. Best flight: August 8, 1901, 389 feet and 17 seconds.

This: Was built by SDASM volunteers at Gillespie Field in 2002/3. It weighs 98 lbs. Displayed in 2003, for 100th anniversary celebration of powered flight.

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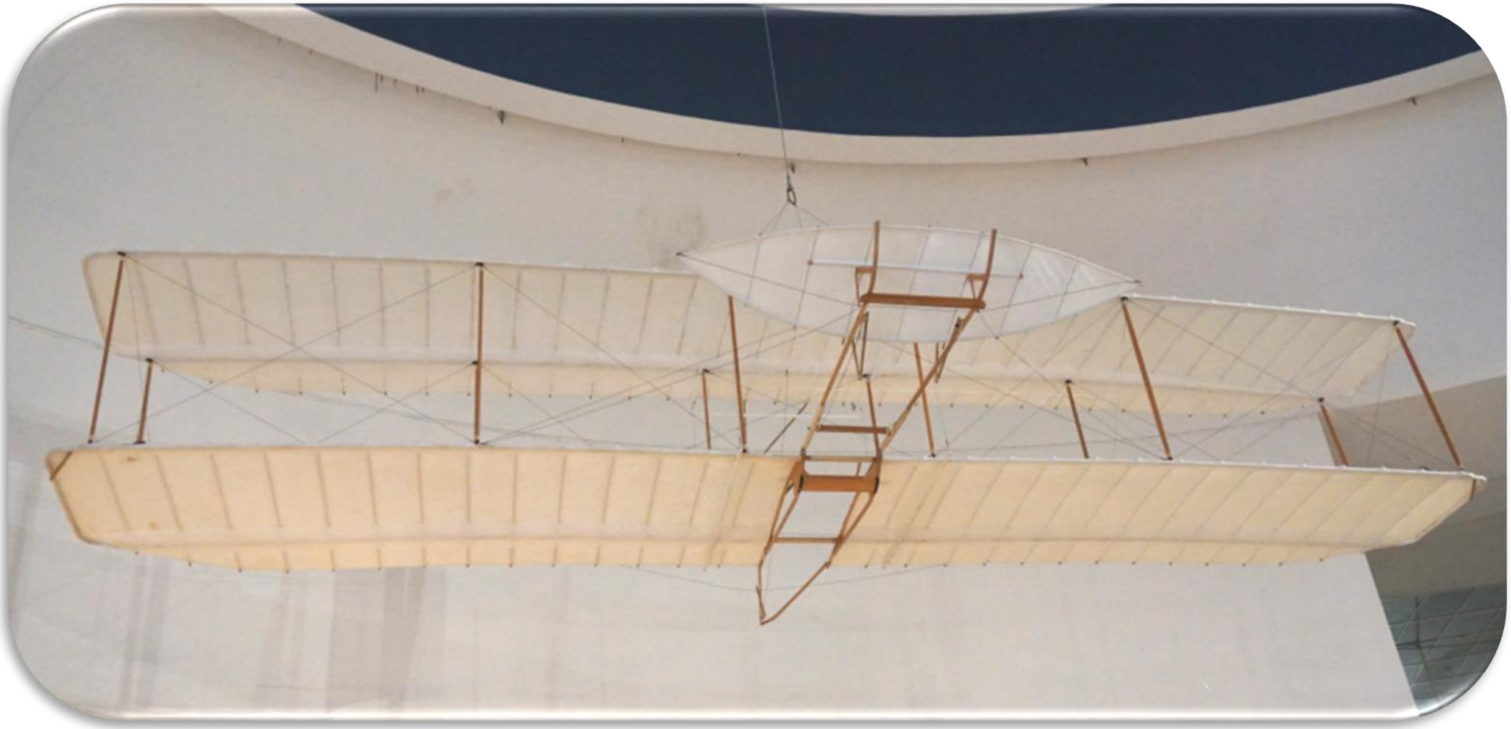

1^{st} flight: 1902

Key Points: **1902 Wright Glider** (Reproduction). Flown in the summer of 1902, this was their **third glider**. Design based on wind tunnel tests, **included a rudder**, weighed 117 lbs. **First aircraft to demonstrate fully controlled movement in all three axes of flight motion: pitch, roll, and yaw. Acknowledged as the world's first practical aircraft**. **Led directly to first powered flights of the 'Wright Flyer' in December 1903.**

This: 1902 glider is primarily the work of Mike Aten, Ben Barackman, Karen and Scott Hazel, who built it in 2002/03, with financial assistance by SDASM. No original drawings survived; built from photographs taken by Orville Wright. Donated December, 2003, centerpiece of 100th anniversary of powered flight.

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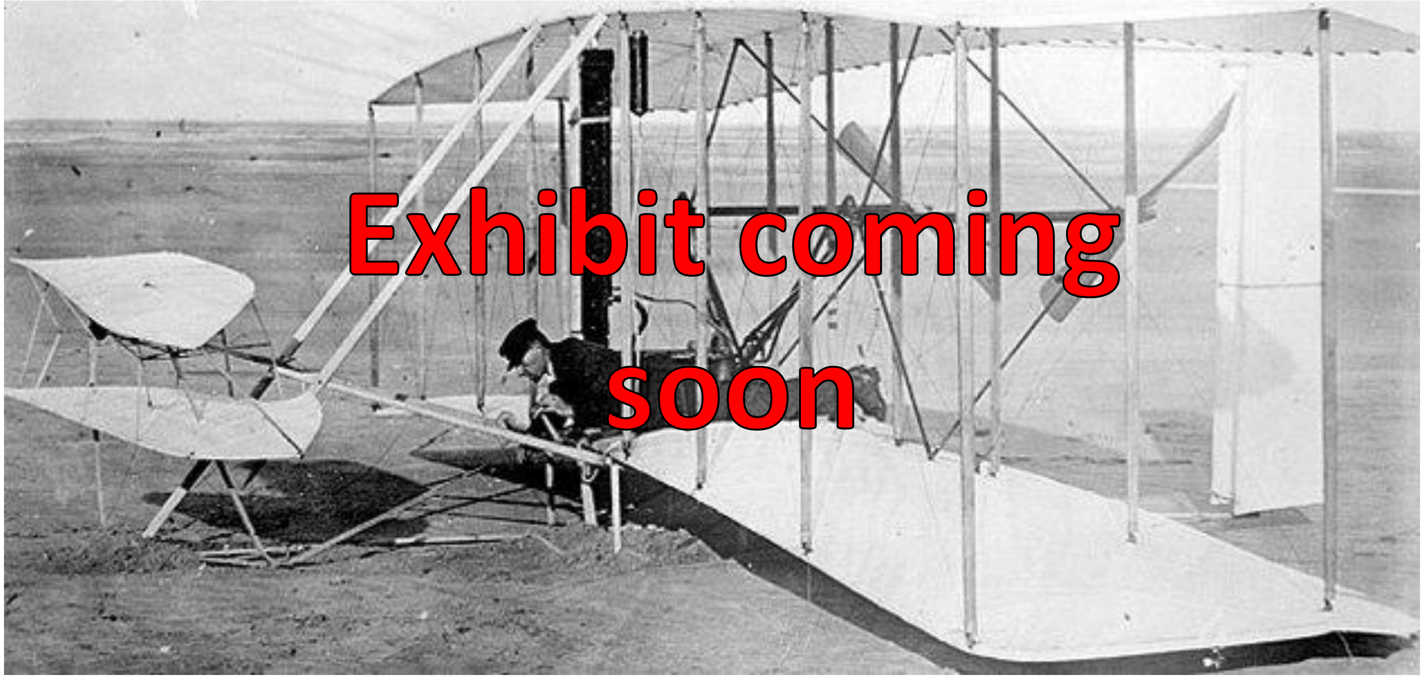

Exhibit coming soon

Key Points: **1903 Wright Flyer** (Reproduction). On **December 17, 1903**, the ‘Flyer’ made the **first successful powered flight in the world** at Kitty Hawk, North Carolina. It flew four times that day. First flight by Orville who was airborne for **12 seconds and covered 120 feet**. The longest flight that day was Wilbur’s **59 second flight which carried him 852 feet**. Made with spruce framework and covered with muslin. The two counter-rotating propellers were carved from laminated spruce and driven with a system of sprockets and chains.

This: Crafted by the Valentine Aero Company of San Luis Obispo, CA. The project was sponsored by the Dayton-Hudson Foundation and was displayed in 1980.

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John J. Montgomery

JOHN J. MONTGOMERY
PIONEER AVIATOR & INVENTOR
John J. Montgomery

Key Points: **John J. Montgomery.** (1858 - 1911). **In 1881-82**, Montgomery began work in aeronautics. Early developer of the **curved wing surface**.

- Likely made the **first human-carrying glider flight in America**, August 28, **1883**, when he flew **600 feet at a height of 15 feet** from Wheeler Hill, **Otay Mesa**, San Diego, CA.
- Wrote a booklet about the theories of flight called "**Aeroplane**".
- Granted the first "aeroplane" **patent** Sep 18, 1906.
- Called the "**Father of basic flying**".
- In 1946, a full-length movie titled ***Gallant Journey*** based on John Montgomery's life and aeronautical work starred Glenn Ford and Janet Blair.

Perhaps 1st human-carrying glider flight in U.S. – **1883**

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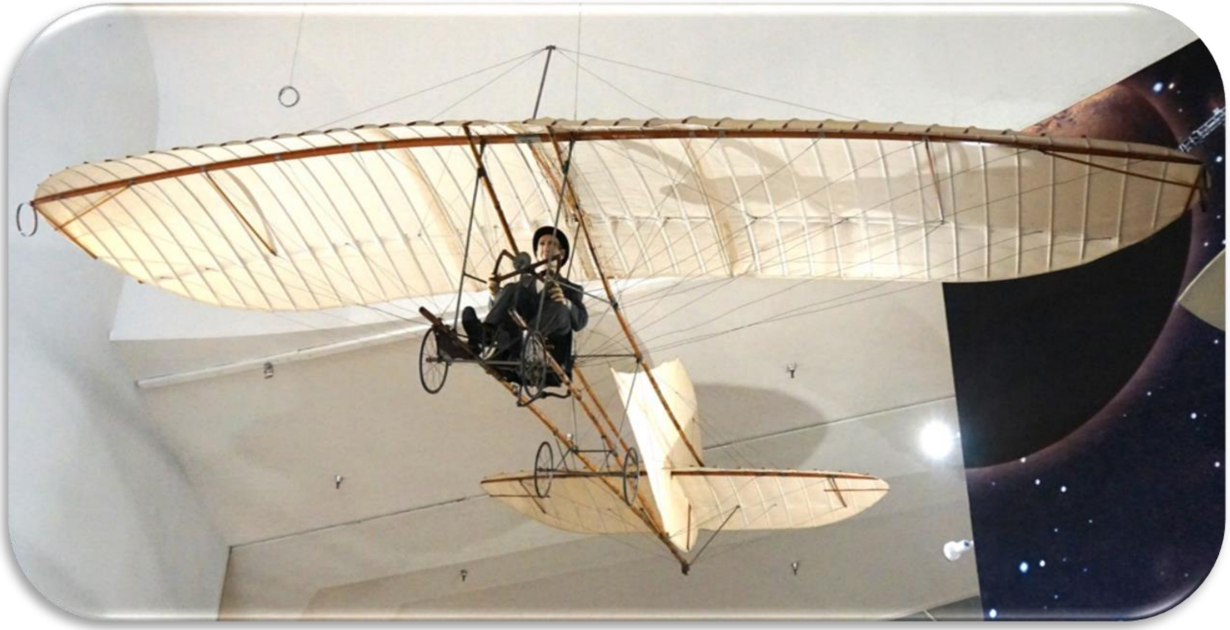

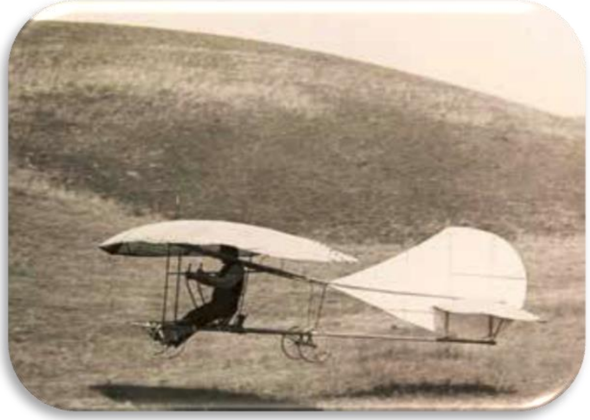

1st flight: 1911

Extra Info: **Montgomery Evergreen Glider (Partial Original).** Montgomery's **last and most advanced glider**, the Evergreen, was the one in which he was killed. The glider was built with **curved** wing surfaces and **controllable** flight surfaces. With four wheels, it was launched from a track. Flights began **October 17, 1911**, in preparation for adding an engine. Most of the **55 glides** were successful, however on October 31, flying at an altitude of less than 20 feet, the Evergreen stalled, came down on the right wing tip, and turned over. Montgomery **hit his head on an exposed bolt** and died two hours later.

This: The Museum's Evergreen glider was restored using many of the original parts.

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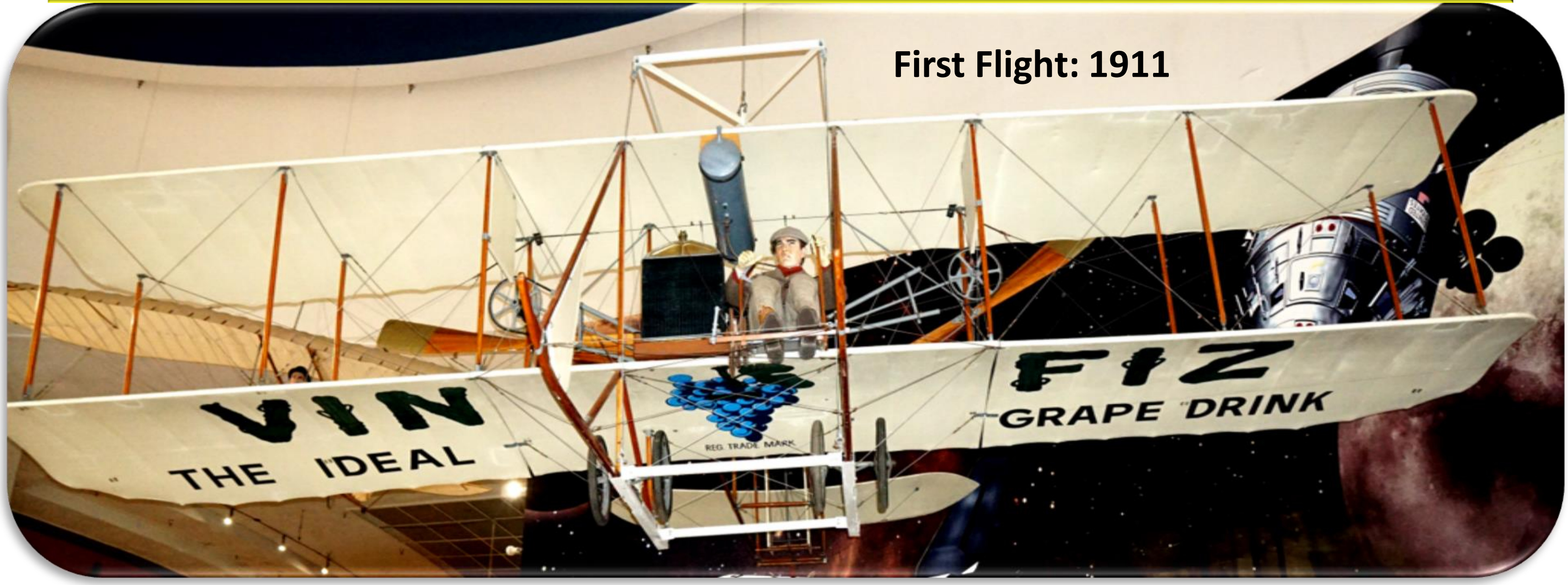

First Flight: 1911

Key Points: **Wright EX Vin Fiz** (Reproduction) **Completed first flight across U.S. trying to win Hearst $50K prize for first flight crossing U.S. in less than 30 days.** Piloted by Calbraith Rodgers, sponsored by Armour Co. to advertise their grape soda "Vin Fiz." Powered by a **35-horsepower, Wright inline 4 cylinder engine**, and it carried enough fuel for a maximum of 3½ hours flying time. Performance: Max speed 55 mph, cruise speed 51 mph, range 190 miles.

This: The Museum's reproduction Vin Fiz is the product of legendary aviation author Peter Bowers. It was built in 1961 to commemorate the 50th anniversary of the first transcontinental flight. The airplane is built to air-worthy standards and has been flown as a towed glider.

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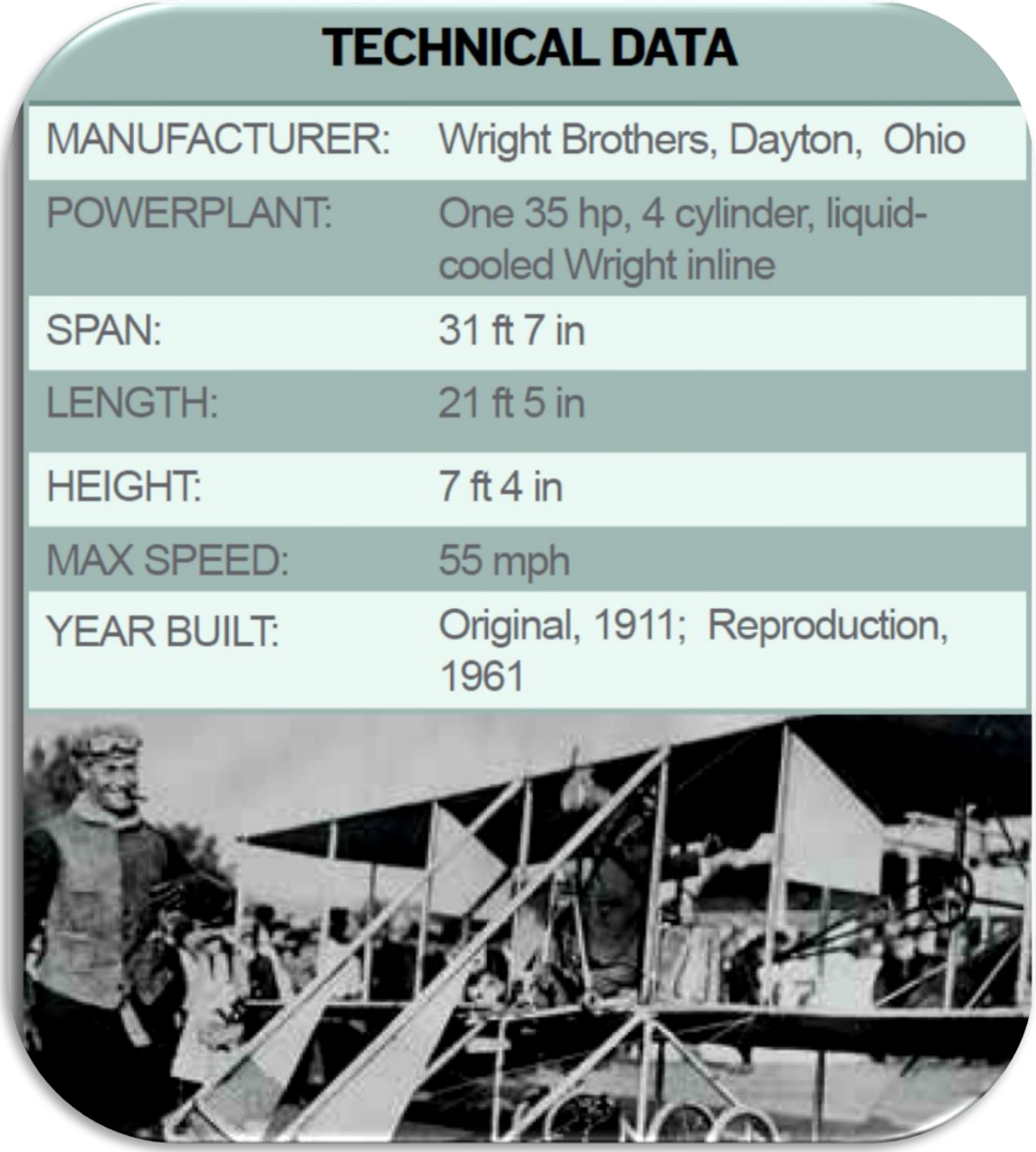

TECHNICAL DATA

MANUFACTURER:	Wright Brothers, Dayton, Ohio
POWERPLANT:	One 35 hp, 4 cylinder, liquid-cooled Wright inline
SPAN:	31 ft 7 in
LENGTH:	21 ft 5 in
HEIGHT:	7 ft 4 in
MAX SPEED:	55 mph
YEAR BUILT:	Original, 1911; Reproduction, 1961

Extra Info: Special railroad car outfitted to support the trip. **75 stops along the way of which at least a dozen were crashes…Rodgers was injured several times**. Only a few pieces of the original plane made the entire trip. After flying approximately **4,300 miles, taking 84 flight hours and over 49 days,** Rodgers landed his plane on the beach at Long Beach, CA. On **April 3, 1912,** while flying over Long Beach, he flew into a flock of birds, causing the plane he was flying to **crash into the ocean and he died.** What remains of the original Vin Fiz is held by the Smithsonian.

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BELL Aircraft

1st Flight:
1946
(7 built)

Key Points: **Bell X-1**, (Full sized mockup) built **1945**, by **Bell Aircraft Company**. On **October 14, 1947, first manned airplane to intentionally exceed the speed of sound in level flight**. USAAF **Captain Charles "Chuck" Yeager,** piloting aircraft #46-062 (nicknamed *Glamorous Glennis,* after his wife), release launched from B-29 (flown by **Robert L. Cardenas**, San Diego resident), and reached **Mach 1.06** (700+ miles per hour). **7 total X-1s built.** Reaction Motors, **Four-chamber rocket engine**; ethyl alcohol and liquid oxygen oxidizer. Basically a "bullet with wings", **shaped like a .50- caliber bullet.** Following burnout glides to a landing on the dry lake bed near Muroc Army Air Field (Now Edwards AFB) near Palmdale, CA. **Record flight was X-1's flight number 50**. Although **Scott Crossfield** was the first to fly faster than Mach 2 in 1953, **Yeager,** shortly thereafter, set a new record of Mach 2.44.

This: Full sized mockup built by SDASM restoration volunteers (2015).

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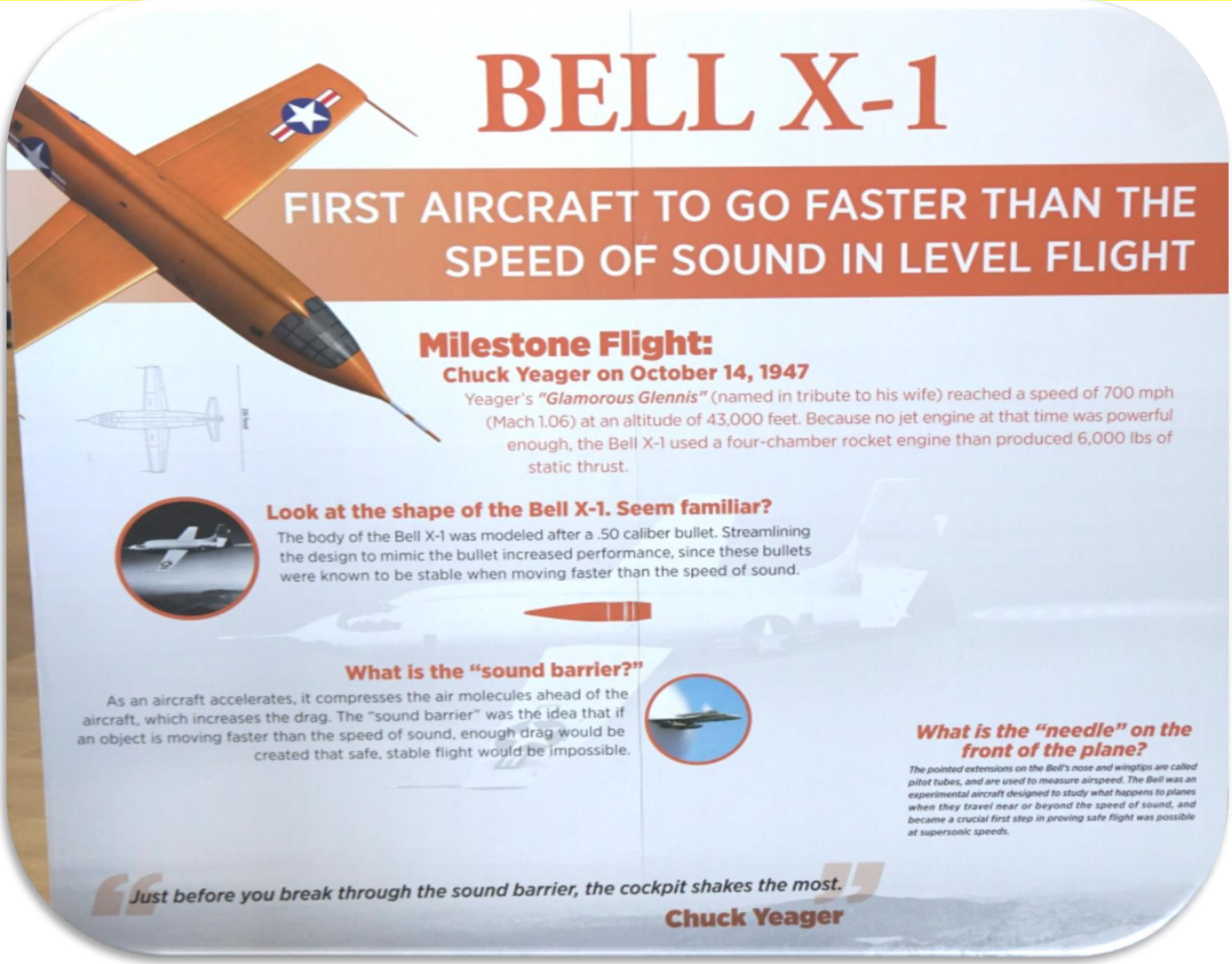

BELL X-1

FIRST AIRCRAFT TO GO FASTER THAN THE SPEED OF SOUND IN LEVEL FLIGHT

Milestone Flight:

Chuck Yeager on October 14, 1947

Yeager's ***"Glamorous Glennis"*** (named in tribute to his wife) reached a speed of 700 mph (Mach 1.06) at an altitude of 43,000 feet. Because no jet engine at that time was powerful enough, the Bell X-1 used a four-chamber rocket engine than produced 6,000 lbs of static thrust.

Look at the shape of the Bell X-1. Seem familiar?

The body of the Bell X-1 was modeled after a .50 caliber bullet. Streamlining the design to mimic the bullet increased performance, since these bullets were known to be stable when moving faster than the speed of sound.

What is the "sound barrier?"

As an aircraft accelerates, it compresses the air molecules ahead of the aircraft, which increases the drag. The "sound barrier" was the idea that if an object is moving faster than the speed of sound, enough drag would be created that safe, stable flight would be impossible.

What is the "needle" on the front of the plane?

The pointed extensions on the Bell's nose and wingtips are called pitot tubes, and are used to measure airspeed. The Bell was an experimental aircraft designed to study what happens to planes when they travel near or beyond the speed of sound, and became a crucial first step in proving safe flight was possible at supersonic speeds.

> *"Just before you break through the sound barrier, the cockpit shakes the most."*
>
> **Chuck Yeager**

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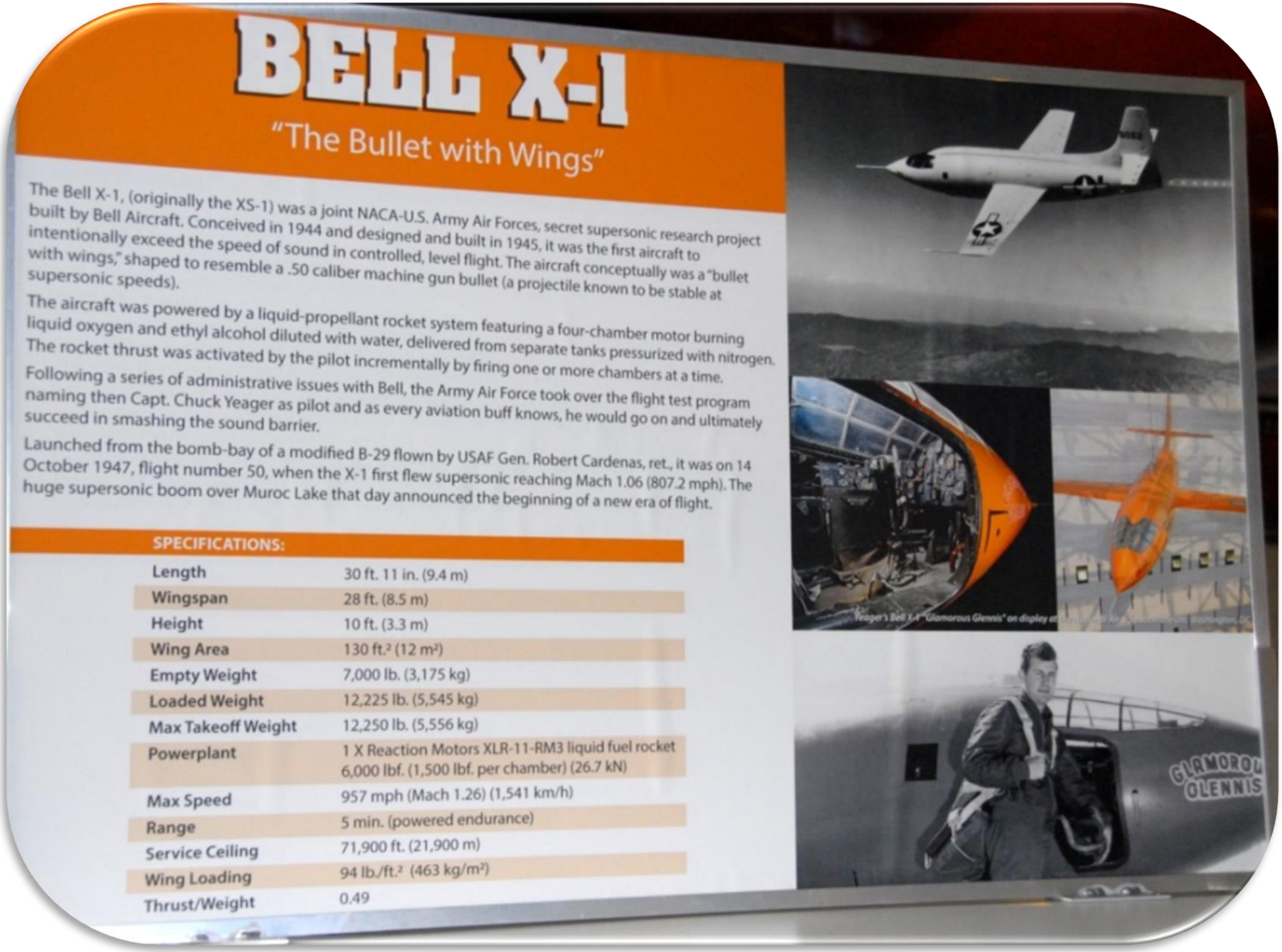

BELL X-1

"The Bullet with Wings"

The Bell X-1, (originally the XS-1) was a joint NACA-U.S. Army Air Forces, secret supersonic research project built by Bell Aircraft. Conceived in 1944 and designed and built in 1945, it was the first aircraft to intentionally exceed the speed of sound in controlled, level flight. The aircraft conceptually was a "bullet with wings," shaped to resemble a .50 caliber machine gun bullet (a projectile known to be stable at supersonic speeds).

The aircraft was powered by a liquid-propellant rocket system featuring a four-chamber motor burning liquid oxygen and ethyl alcohol diluted with water, delivered from separate tanks pressurized with nitrogen. The rocket thrust was activated by the pilot incrementally by firing one or more chambers at a time.

Following a series of administrative issues with Bell, the Army Air Force took over the flight test program naming then Capt. Chuck Yeager as pilot and as every aviation buff knows, he would go on and ultimately succeed in smashing the sound barrier.

Launched from the bomb-bay of a modified B-29 flown by USAF Gen. Robert Cardenas, ret., it was on 14 October 1947, flight number 50, when the X-1 first flew supersonic reaching Mach 1.06 (807.2 mph). The huge supersonic boom over Muroc Lake that day announced the beginning of a new era of flight.

SPECIFICATIONS:

Length	30 ft. 11 in. (9.4 m)
Wingspan	28 ft. (8.5 m)
Height	10 ft. (3.3 m)
Wing Area	130 ft.² (12 m²)
Empty Weight	7,000 lb. (3,175 kg)
Loaded Weight	12,225 lb. (5,545 kg)
Max Takeoff Weight	12,250 lb. (5,556 kg)
Powerplant	1 X Reaction Motors XLR-11-RM3 liquid fuel rocket 6,000 lbf. (1,500 lbf. per chamber) (26.7 kN)
Max Speed	957 mph (Mach 1.26) (1,541 km/h)
Range	5 min. (powered endurance)
Service Ceiling	71,900 ft. (21,900 m)
Wing Loading	94 lb./ft.² (463 kg/m²)
Thrust/Weight	0.49

Yeager's Bell X-1 "Glamorous Glennis" on display at [illegible] Air & Space Museum, Washington, DC

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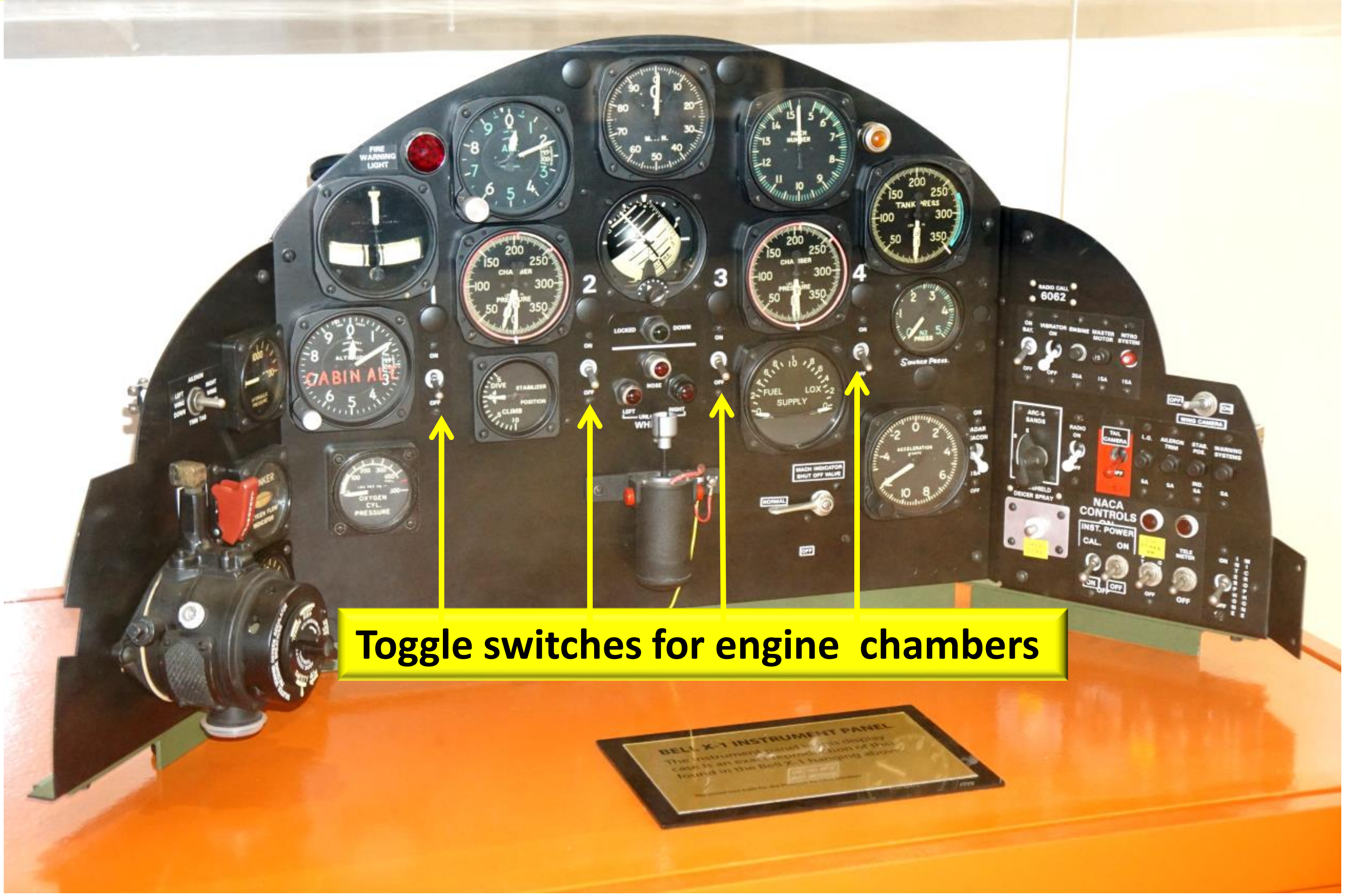
Bell X-1 Instrument Panel



Toggle switches for engine chambers

Key Points: Thrust was not controlled with a typical “throttle” control lever on the X-1. Each chamber of the four-chamber rocket engine was turned on and off by a toggle switch. To increase rocket thrust (and speed) the Test Pilot switched on more chambers; they were labeled simply 1, 2, 3 & 4.

This: The panel was built for the Museum by **Clint Gardner**

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Rotunda Gallery

Key Points: **History of the Art and Craft of Aircraft Models.** Nearly all human carrying aircraft, at some point between idea and production, were models for either **concept, design, compatibility, function or display** . Successful aircraft had models built for evolution and/or historical remembrance.

Model **hobbyists** and **sport enthusiasts** found new challenges to exercise their creativity and craftsmanship in construction techniques (paper to carbon fiber), controllability (from free flight to wire to wireless transmitters) and especially in propulsion methods (rubber bands to miniature jets).

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Rotunda Gallery

William Samuel Henson's 1843 Patent of the First Practical Model Aircraft
Henson Stringfellow 1847 10' Flying Model
L

Key Points: **History of the Art and Craft of Aircraft Models.** Two additional display cases are located in the walk way to the Space Gallery.

Space Gallery

1950's to Today

Maned - Unmanned - Exploration

Space Gallery

SPACE
OUR GREATEST ADVENTURE
ENTER HERE

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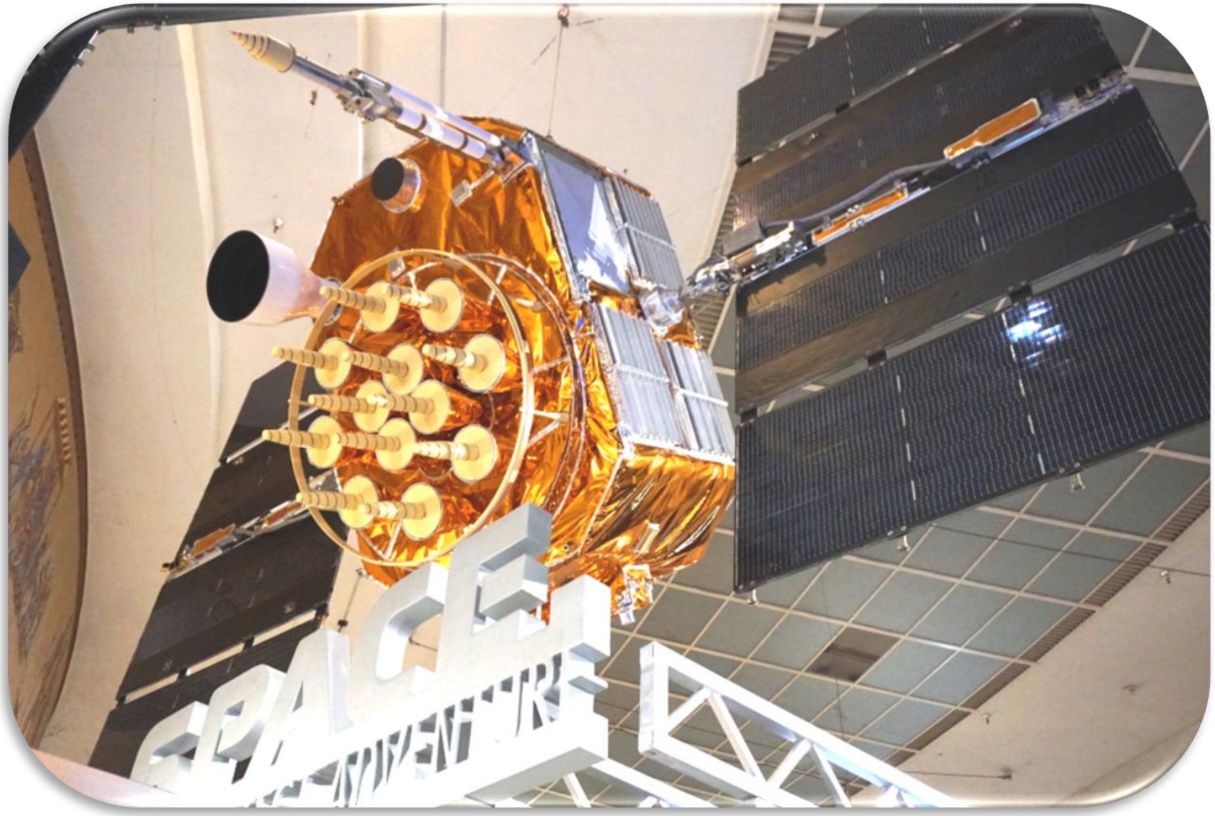
Space Gallery



1st Satellite launch: 1978

Key Points:

Boeing GPS-12 Satellite (Original). Satellite navigation theorized in 1957. Work started in 1959 for Navy's Polaris Submarines. With a 12,600 mi orbit, the GPS was designed to have at least 9 satellites in constant view from anywhere on earth.

This: Boeing GPS satellite was built in 1983/4 and is the **only GPS satellite on display in the world**. Originally intended as a replacement into the Rockwell GPS system. After many modifications it was designated as a **test bed for program development**.

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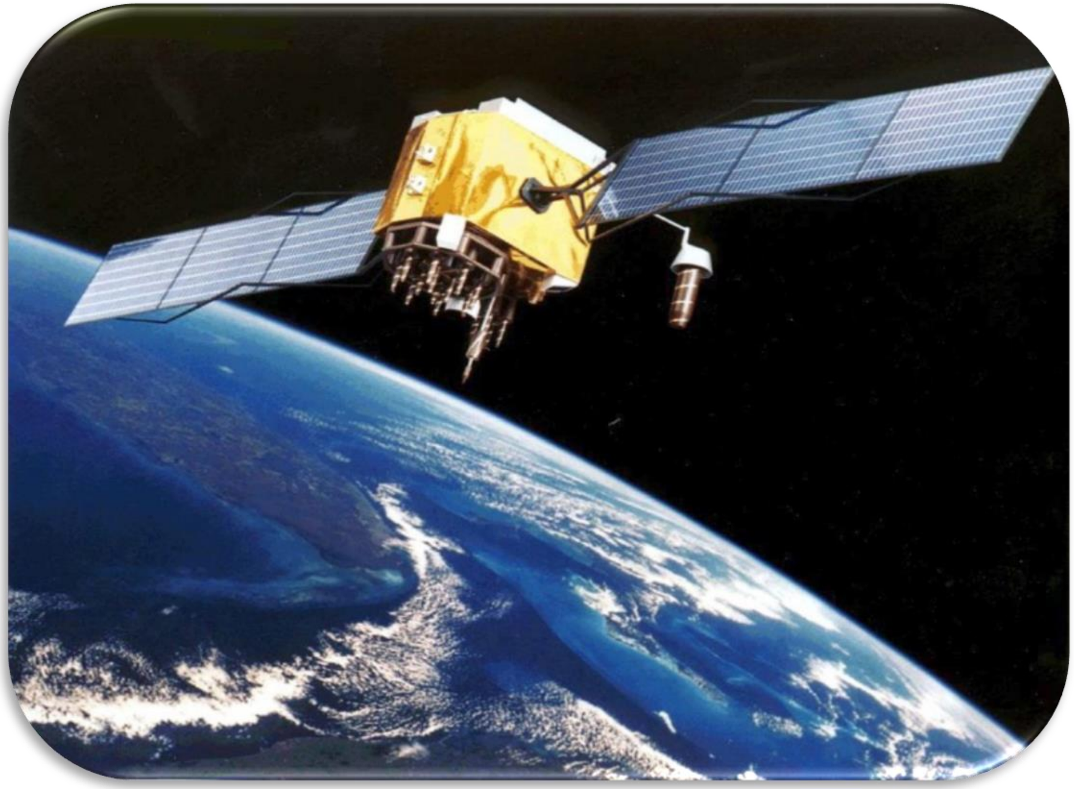

Extra Info: The Global Positioning System (GPS) is the most significant recent advancement in navigation. A constellation of 31 satellites continuously transmit a microwave signal controlled by an atomic frequency standard located in Bolder, CO. A minimum of four satellites are required to determine accurate location. Long term measurements by GPS are used to measure continental drift; movements as little as fractions of an inch per year are measured and tracked. The solar panels provide primary power while backup batteries are used to provide the power during solar eclipses. Designed for 12 year service life.

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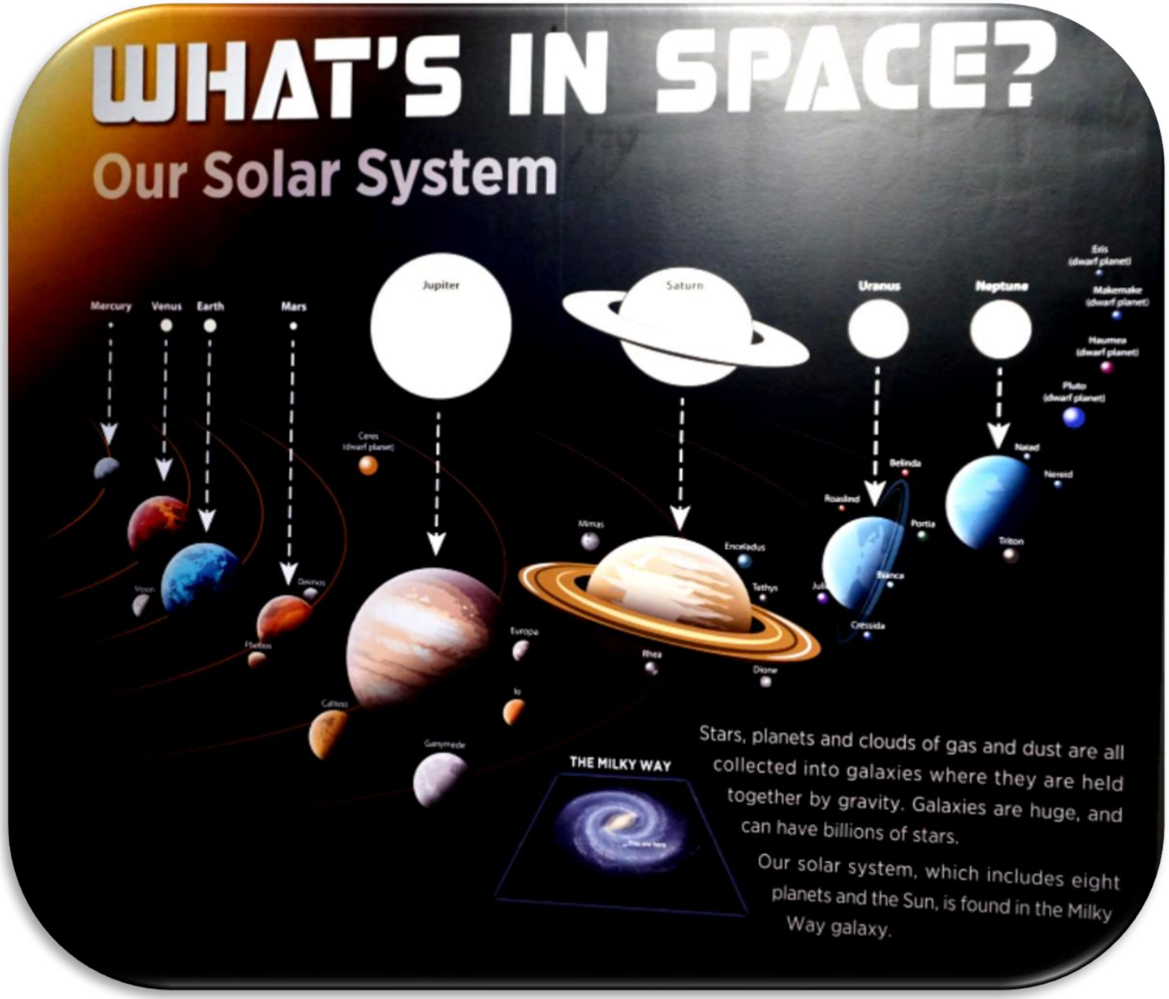

WHAT'S IN SPACE?

Our Solar System

Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune
Eris (dwarf planet)
Makemake (dwarf planet)
Haumea (dwarf planet)
Pluto (dwarf planet)
Ceres (dwarf planet)
Moon
Deimos
Phobos
Europa
Io
Callisto
Ganymede
Mimas
Enceladus
Tethys
Rhea
Dione
Belinda
Roaslind
Portia
Bianca
Cressida
Naiad
Nereid
Triton
THE MILKY WAY

Stars, planets and clouds of gas and dust are all collected into galaxies where they are held together by gravity. Galaxies are huge, and can have billions of stars.

Our solar system, which includes eight planets and the Sun, is found in the Milky Way galaxy.

Key Points: **Our Solar System is only one very small speck as part of our Milky Way Galaxy.** The Milky Way Galaxy contains **BILLIONS** of solar systems.

From here on Earth, besides landing on our Moon, we have sent exploration vehicles to **land or fly close to** all of our Solar Systems planets and many planetary moons, asteroids, and comets.

Exploration by human kind. **Maned Landings** - Our Moon. **Unmanned Landings** - Mars and Venus. **Orbits and Fly-bys** - Neptune, Mercury, Pluto, Uranus. Moons of Mars, Jupiter, Saturn, Uranus & Neptune. **Probes into gaseous atmosphere** - Jupiter and Saturn.

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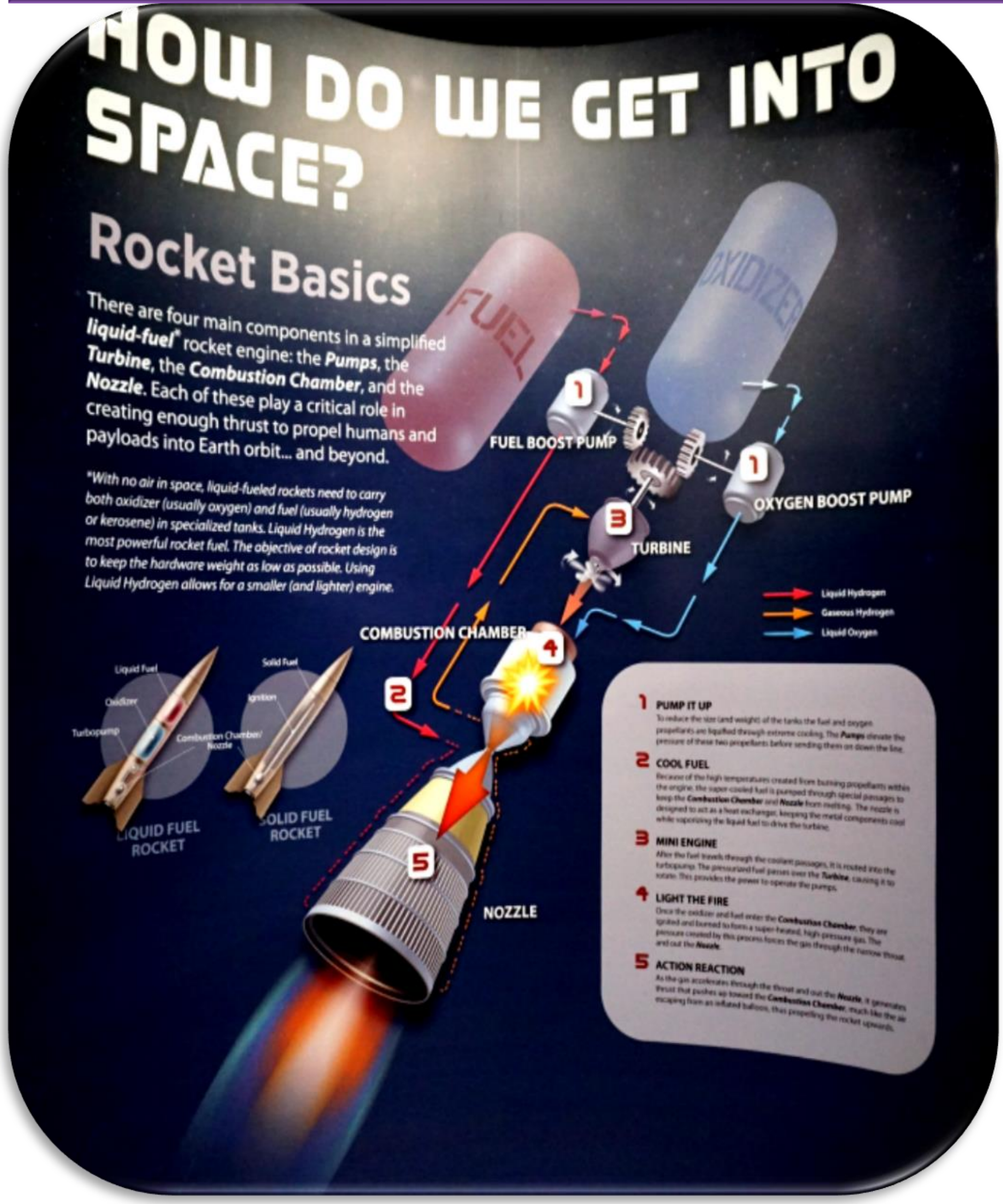

HOW DO WE GET INTO SPACE?

Rocket Basics

There are four main components in a simplified **liquid-fuel*** rocket engine: the ***Pumps***, the ***Turbine***, the ***Combustion Chamber***, and the ***Nozzle***. Each of these play a critical role in creating enough thrust to propel humans and payloads into Earth orbit... and beyond.

**With no air in space, liquid-fueled rockets need to carry both oxidizer (usually oxygen) and fuel (usually hydrogen or kerosene) in specialized tanks. Liquid Hydrogen is the most powerful rocket fuel. The objective of rocket design is to keep the hardware weight as low as possible. Using Liquid Hydrogen allows for a smaller (and lighter) engine.*

FUEL
OXIDIZER
1
FUEL BOOST PUMP
1
OXYGEN BOOST PUMP
3
TURBINE
Liquid Hydrogen
Gaseous Hydrogen
Liquid Oxygen
COMBUSTION CHAMBER
4
2
5
NOZZLE
Liquid Fuel
Oxidizer
Turbopump
Combustion Chamber/Nozzle
LIQUID FUEL ROCKET
Solid Fuel
Ignition
SOLID FUEL ROCKET
1 PUMP IT UP
2 COOL FUEL
3 MINI ENGINE
4 LIGHT THE FIRE
5 ACTION REACTION

Key Points: **Solid fuel** is cheaper than liquid fuel but it cannot be controlled as well. **Liquid fuel** is more powerful and lighter and can lift more payload.

Solid fuel rockets today used mostly as booster rockets (Example: Space Shuttle) to provide initial acceleration.

The 4 main components of a **liquid fuel rocket engine** are:

- **Fuel and Oxygen pressure boost pumps,**
- **Turbine, to power boost pumps,**
- **Combustion Chamber,**
- **Nozzle**.

There is no oxygen in space so liquid fuel (usually liquid hydrogen) is mixed with an oxidizer (usually liquid oxygen) to form a combustible propellant.

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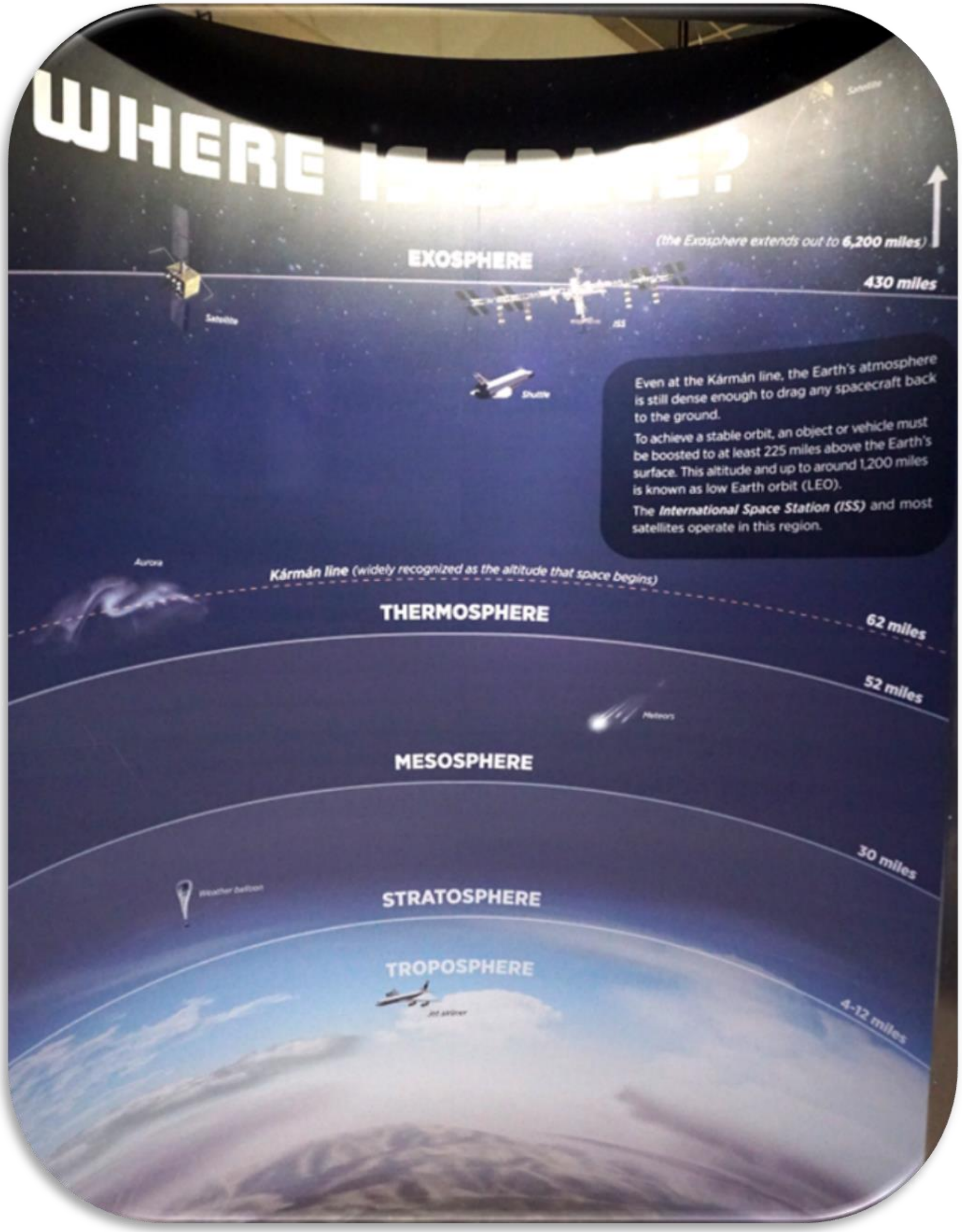
WHERE IS SPACE?
Satellite
(the Exosphere extends out to 6,200 miles)
EXOSPHERE
430 miles
Satellite
ISS
Shuttle
Aurora
Kármán line (widely recognized as the altitude that space begins)
THERMOSPHERE
62 miles
52 miles
Meteors
MESOSPHERE
30 miles
Weather balloon
STRATOSPHERE
TROPOSPHERE
Jet airliner
4-12 miles

Even at the Kármán line, the Earth's atmosphere is still dense enough to drag any spacecraft back to the ground.

To achieve a stable orbit, an object or vehicle must be boosted to at least 225 miles above the Earth's surface. This altitude and up to around 1,200 miles is known as low Earth orbit (LEO).

The ***International Space Station (ISS)*** and most satellites operate in this region.

Key Points: **Where does SPACE start?**

Answer: **62 Miles** (above sea level). Called the **Kármán line**, it is conventionally used as the start of outer space in space treaties and for aerospace records keeping.

To achieve a stable orbit requires at least a **225 mile orbit;** This is called a Low Earth Orbit or LEO, and continues **up to 1200 miles**. Most satellites and the ISS (International Space Station) orbit at these LEO altitudes above the surface of the Earth. A notable exception is the James Webb Telescope which will orbit at 1 million miles (4 times the distance to our moon).

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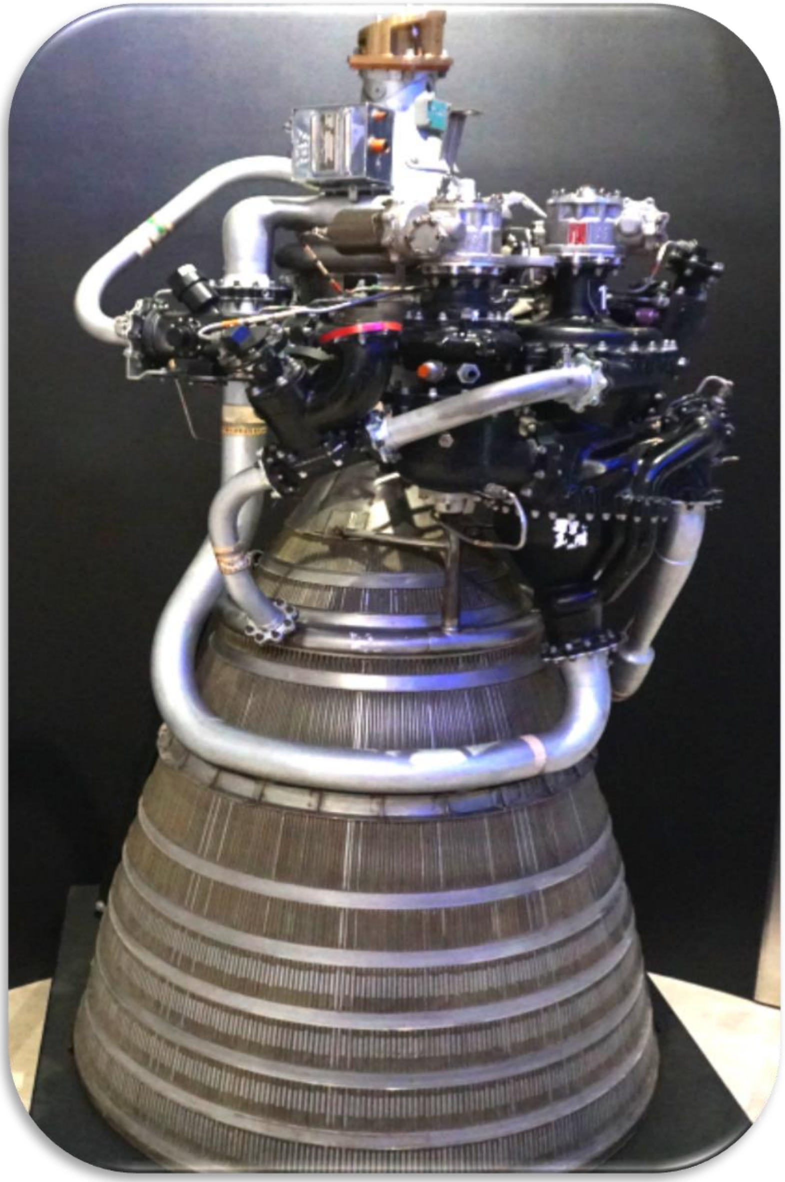
Space Gallery

Key Points: RL 10 Rocket Engine (Original). Built by Aerojet (now Aerojet Rocketdyne) is the **nations premier upper stage rocket engine**. Note the tubes surrounding the engine nozzle bell. Rocket fuel passes thru these tubes to cool the nozzle and bell during combustion. Then the fuel flows thru the turbine and into the combustion chamber where it is mixed with oxidizer and ignited.



1st Run: 1962

Note: 58 years and counting - the RL-10 engine was used on the Centaur upper stage rocket to boost the **Perseverance Rover Vehicle (JPL)** into earth orbit and then boosted it out of earth orbit for a **landing on Mars.** Launched **July 30, 2020**, it is expected to **land on Mars Feb 18, 2021.**

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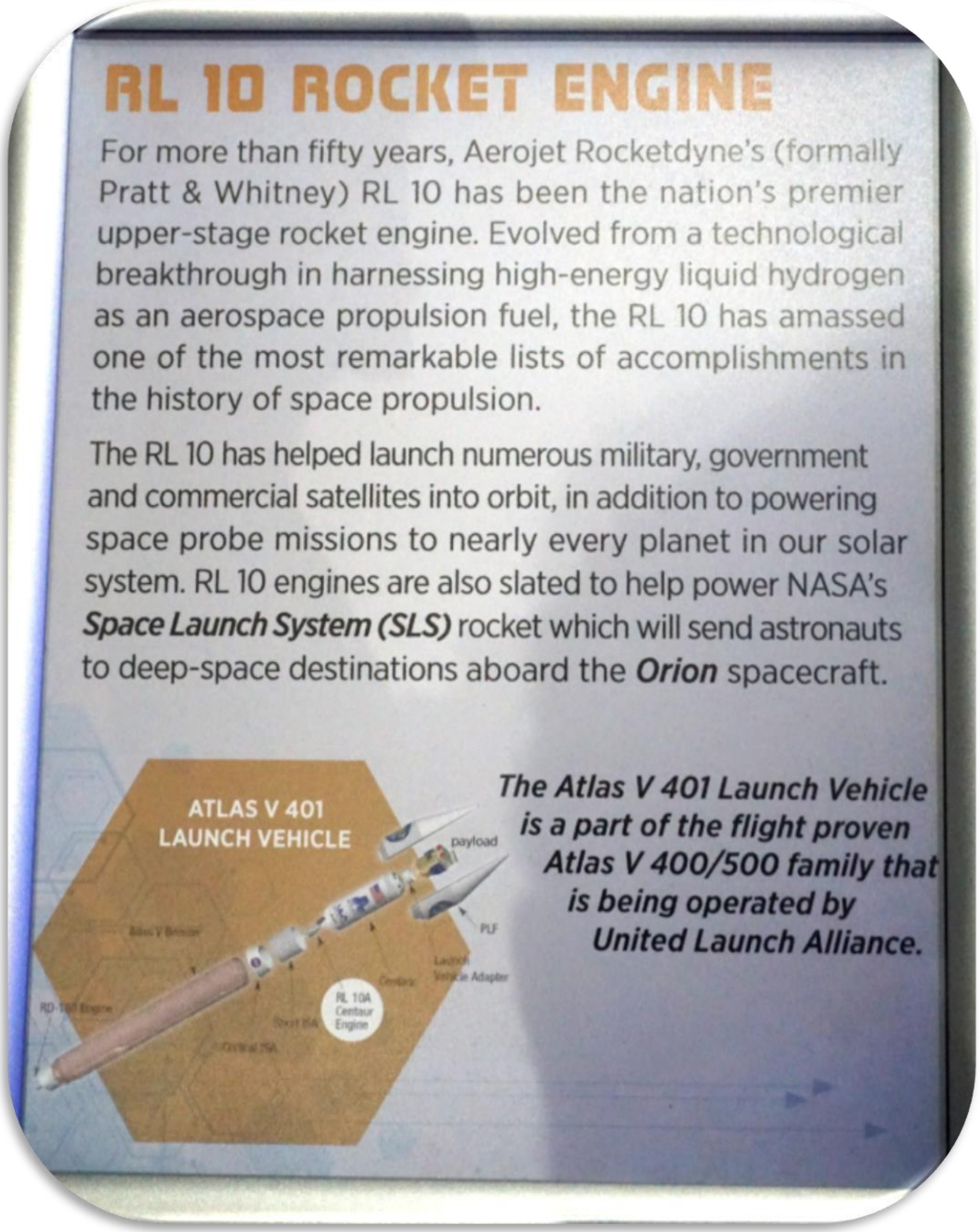
Space Gallery



RL 10 ROCKET ENGINE

For more than fifty years, Aerojet Rocketdyne's (formally Pratt & Whitney) RL 10 has been the nation's premier upper-stage rocket engine. Evolved from a technological breakthrough in harnessing high-energy liquid hydrogen as an aerospace propulsion fuel, the RL 10 has amassed one of the most remarkable lists of accomplishments in the history of space propulsion.

The RL 10 has helped launch numerous military, government and commercial satellites into orbit, in addition to powering space probe missions to nearly every planet in our solar system. RL 10 engines are also slated to help power NASA's ***Space Launch System (SLS)*** rocket which will send astronauts to deep-space destinations aboard the ***Orion*** spacecraft.

ATLAS V 401 LAUNCH VEHICLE

The Atlas V 401 Launch Vehicle is a part of the flight proven Atlas V 400/500 family that is being operated by United Launch Alliance.

Note: In 2013, GenCorp acquired Pratt & Whitney Rocketdyne from United Technologies Corporation to form Aerojet Rocketdyne, a major leader in the aerospace industry.

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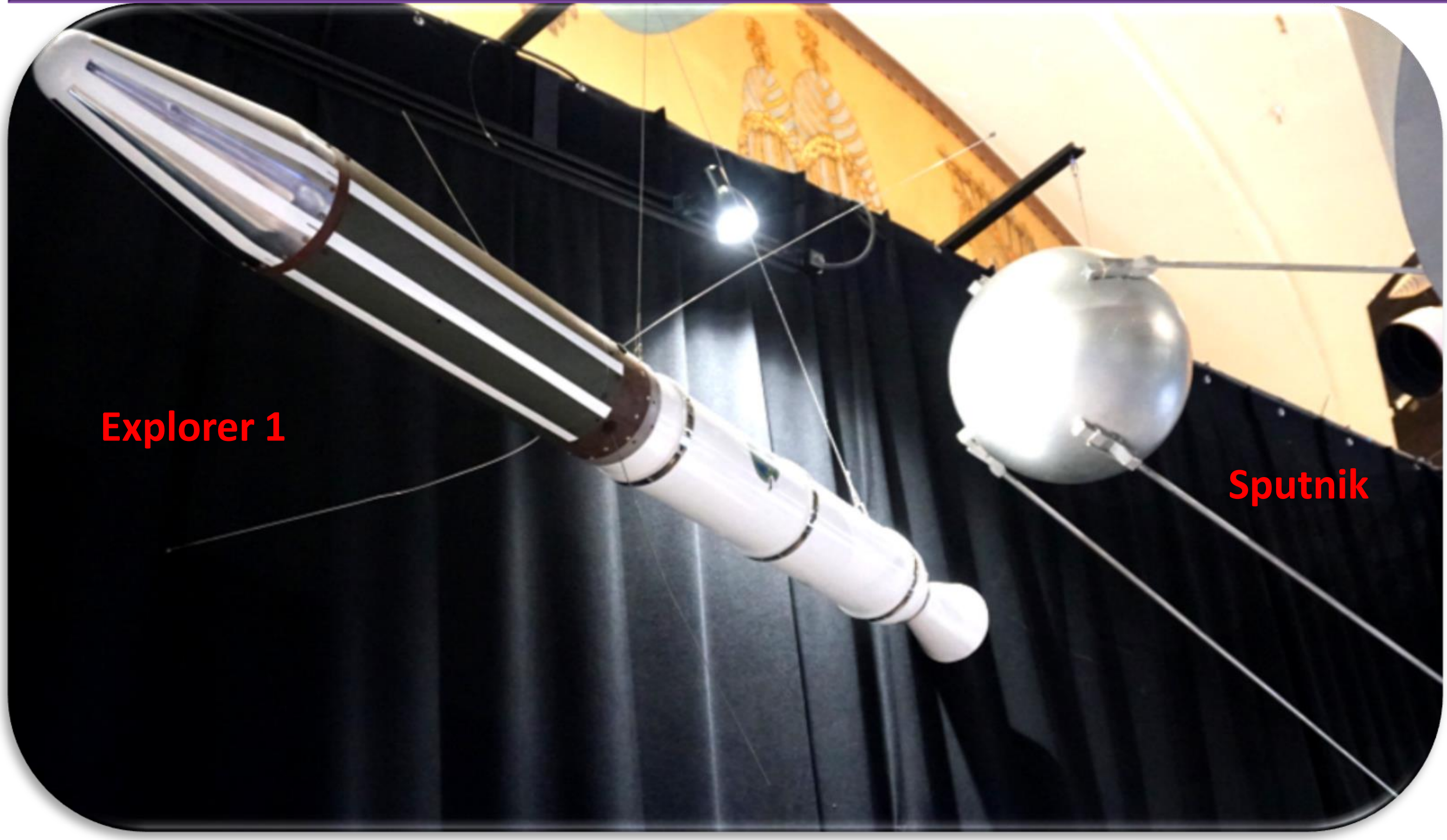
Space Gallery



1st Launch: 1957

Key Points: **Explorer 1 (US) and Sputnik (USSR)** (Full scale mock-up's). **Sputnik - World's first orbital satellite** (by almost 4 months), launched **Oct 4, 1957**. **Explorer 1** - **First United States satellite** (and worlds third) launched **Jan 31, 1958**. Sputnik had two transmitters aboard that sent out a tracking "beep-beep" signal. Explorer 1 had a **transceiver, cosmic ray detector, temperature sensor and micrometeoroid sensor**.

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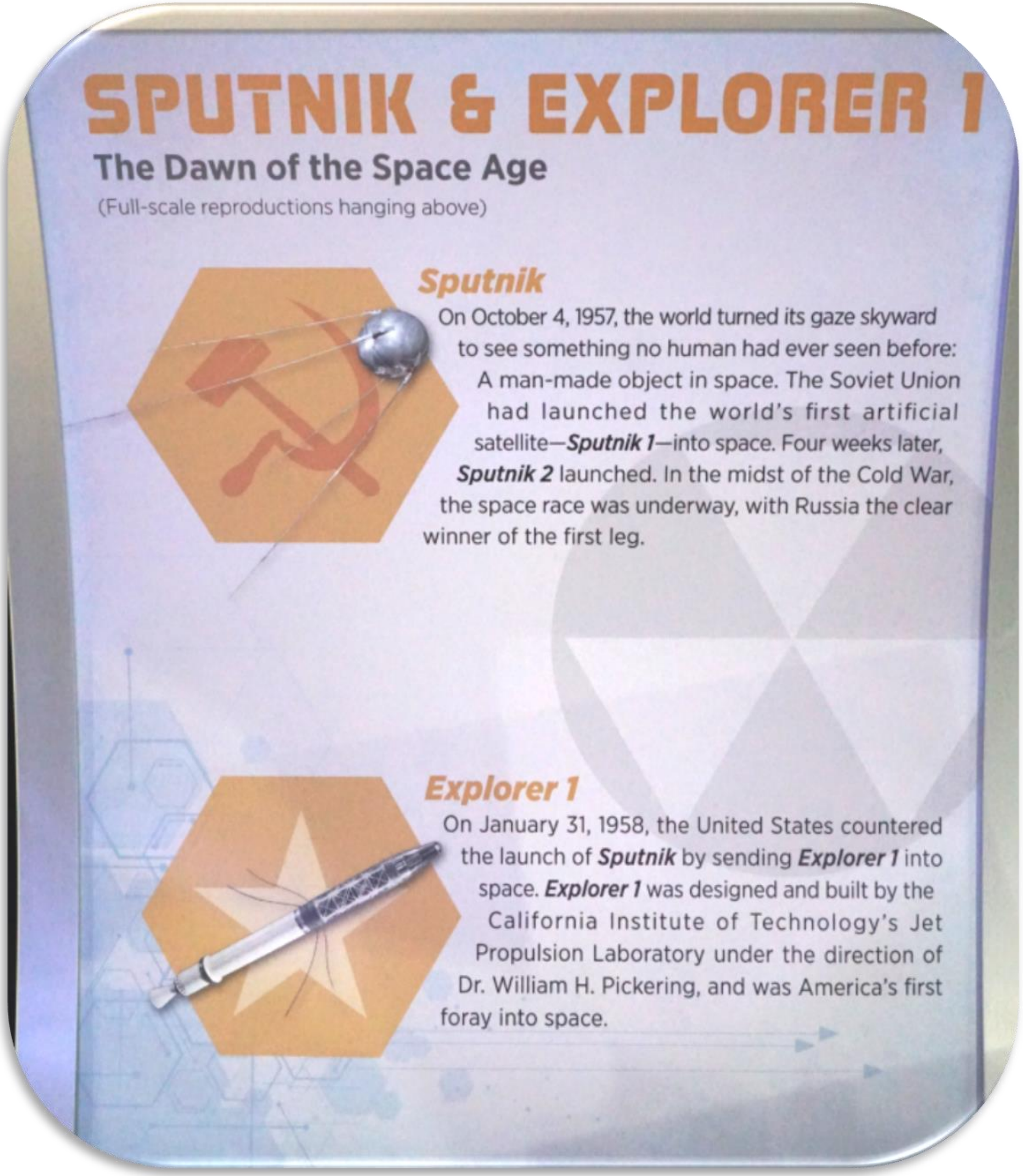
Space Gallery



SPUTNIK & EXPLORER 1

The Dawn of the Space Age

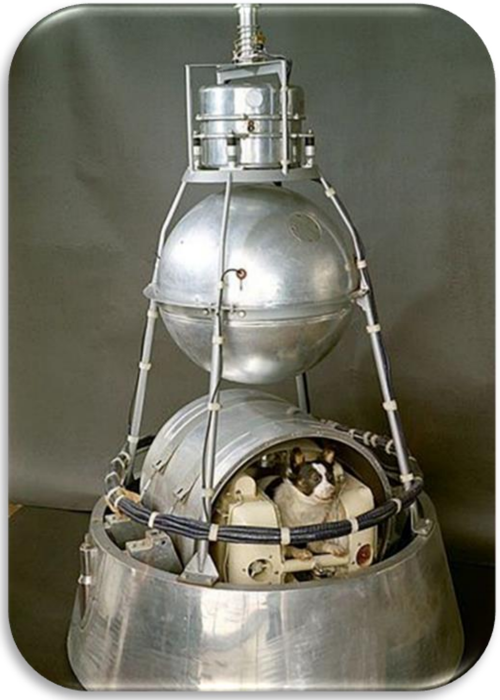
(Full-scale reproductions hanging above)

Sputnik

On October 4, 1957, the world turned its gaze skyward to see something no human had ever seen before: A man-made object in space. The Soviet Union had launched the world's first artificial satellite—***Sputnik 1***—into space. Four weeks later, ***Sputnik 2*** launched. In the midst of the Cold War, the space race was underway, with Russia the clear winner of the first leg.

Explorer 1

On January 31, 1958, the United States countered the launch of ***Sputnik*** by sending ***Explorer 1*** into space. ***Explorer 1*** was designed and built by the California Institute of Technology's Jet Propulsion Laboratory under the direction of Dr. William H. Pickering, and was America's first foray into space.



Sputnik 2 with first space dog.
Sputnik 2 launched **Nov 3, 1957** with dog (Laika) aboard. Laika died on 4th orbit due to faulty Air Conditioning system.

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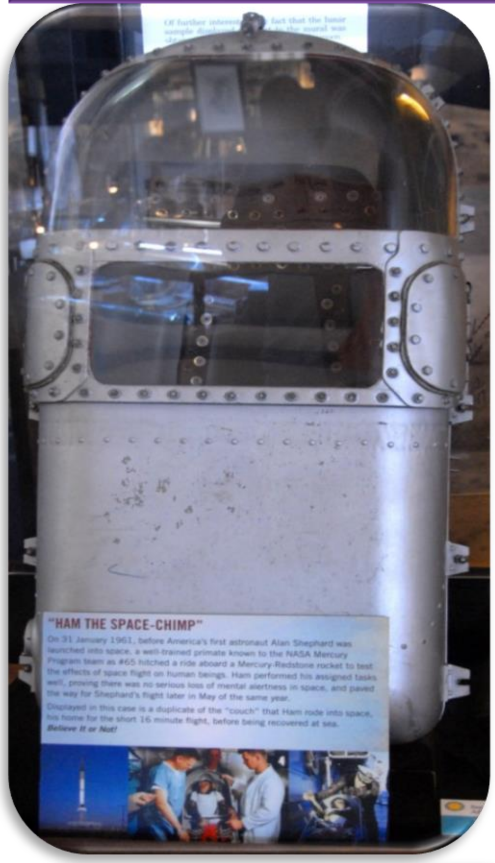
Space Gallery



"HAM THE SPACE-CHIMP"

On 31 January 1961, before America's first astronaut Alan Shephard was launched into space, a well-trained primate known to the NASA Mercury Program team as #65 hitched a ride aboard a Mercury-Redstone rocket to test the effects of space flight on human beings. Ham performed his assigned tasks well, proving there was no serious loss of mental alertness in space, and paved the way for Shephard's flight later in May of the same year.

Displayed in this case is a duplicate of the "couch" that Ham rode into space, his home for the short 16 minute flight, before being recovered at sea. ***Believe It or Not!***

1st Launch: 1961

Key Points: Primate Flight Capsule (**Original training capsule**). Doctors were uncertain about humans in space (radiation, confined space, isolation, acceleration and deceleration, and especially weightlessness). The effect of space flight on a trained Chimpanzee could be studied to determine hazards to human space flight.

January 31, 1961, **Ham** was **first chimpanzee in space**, Mercury Redstone rocket, weightless for 6.6 minutes, 16.5-minute sub-orbital flight. Paved the way for the successful first launch of America's first human, **Alan Shepard**, on May 5, 1961.

November 29, 1961, Enos was the first **chimpanzee to orbit** the Earth (2 orbits) on a Mercury Atlas rocket. Paved the way for the successful first launch of America's first manned orbital flight, by **John Glenn** on February 20, 1962.

This: Is an un-flown training capsule. It is on loan from the Smithsonian National Air & Space Museum.

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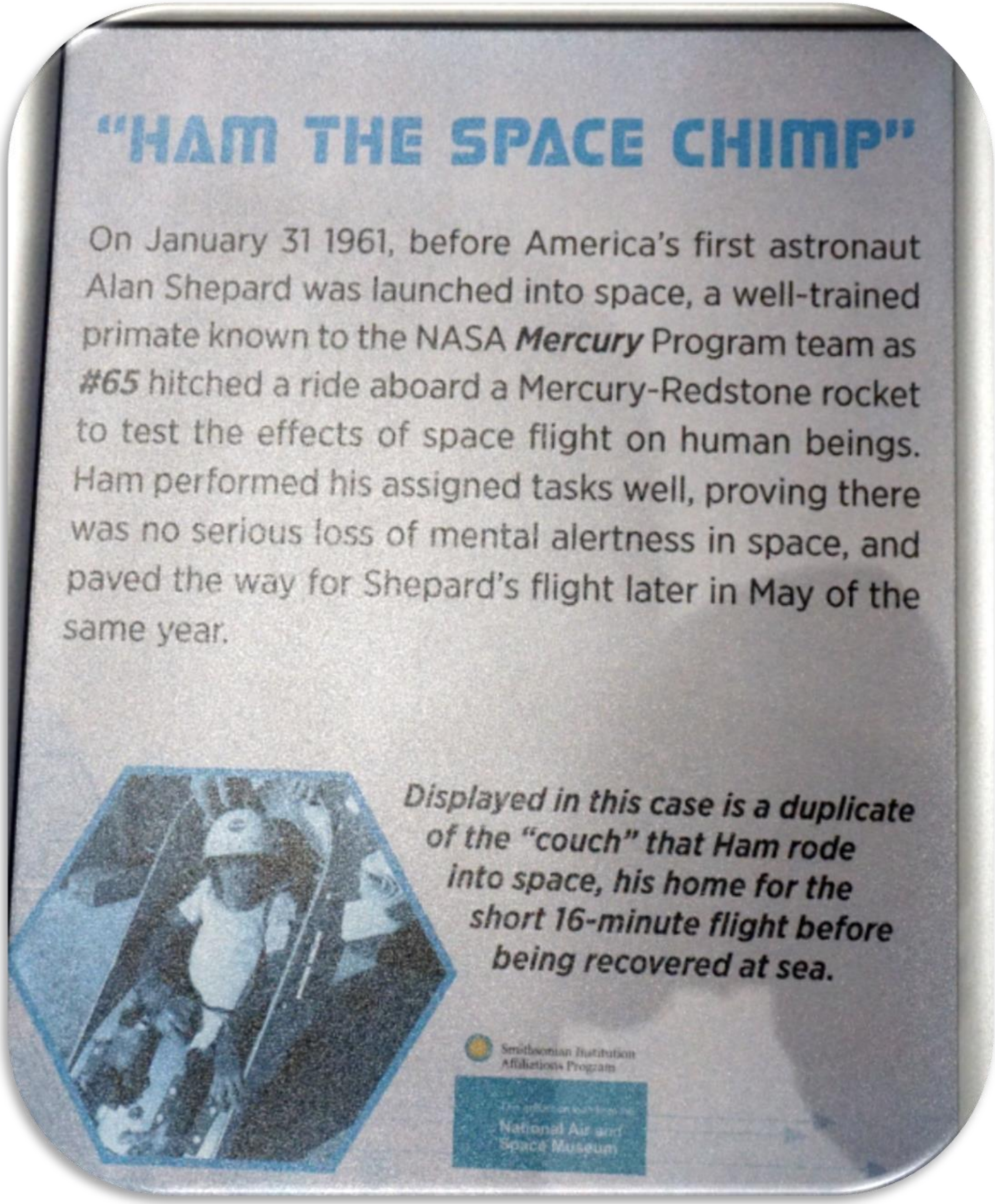
Space Gallery



“HAM THE SPACE CHIMP”

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Smithsonian Institution
Affiliations Program

National Air and
Space Museum

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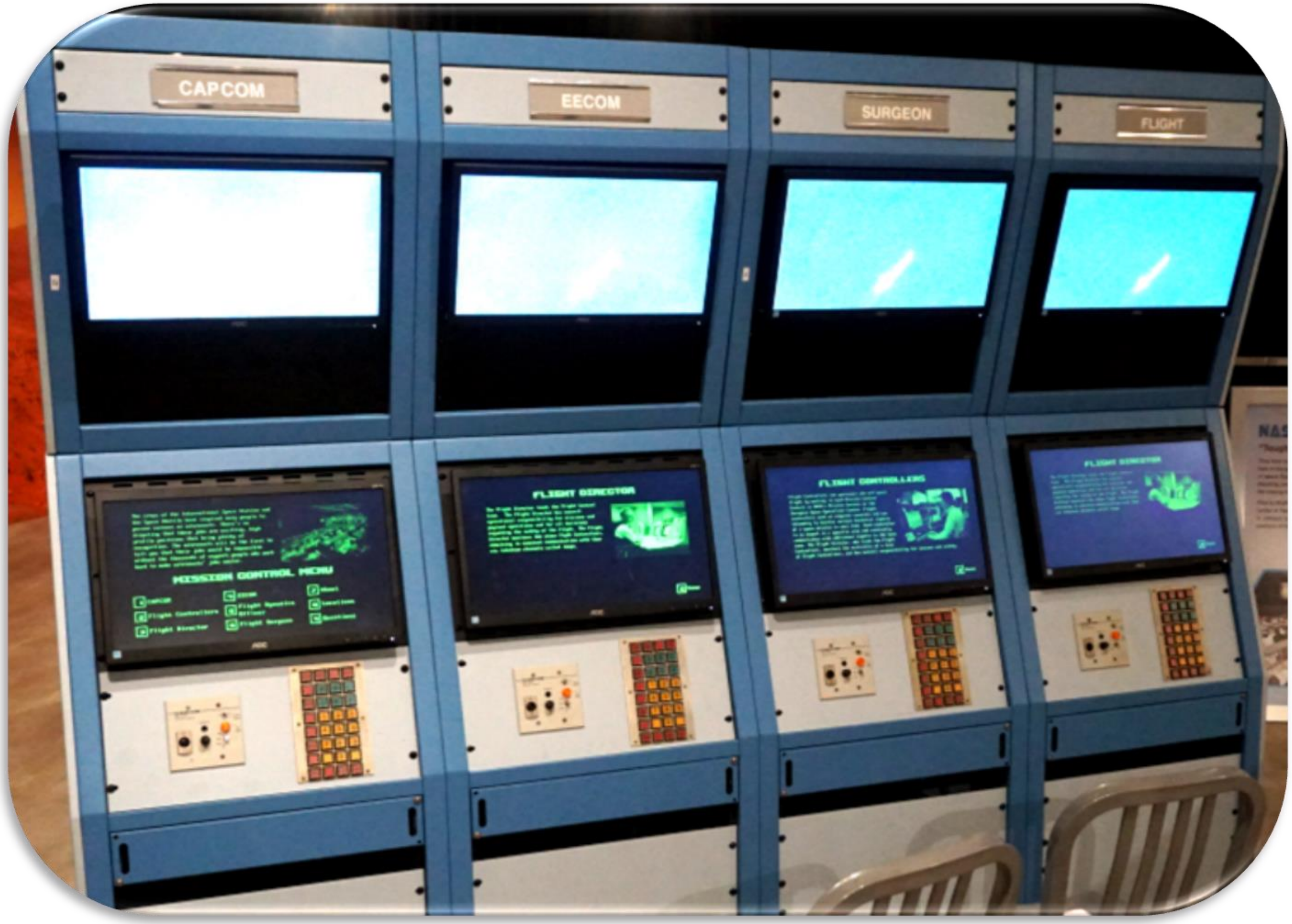
Space Gallery


CAPCOM
EECOM
SURGEON
FLIGHT
FLIGHT DIRECTOR
FLIGHT CONTROLLERS
MISSION CONTROL MENU

Mission Control Center moved to Houston: 1965

Key Points: **NASA's Mission Control** (Mock-up). Once a spacecraft clears the launch tower, responsibility for the spacecraft is transferred from Launch Control Center (Kennedy Space Center, FL) to Mission Control Center (Johnson Space Center, TX). This interactive Mission Control simulator engages guests to learn the functions of Mission Control.

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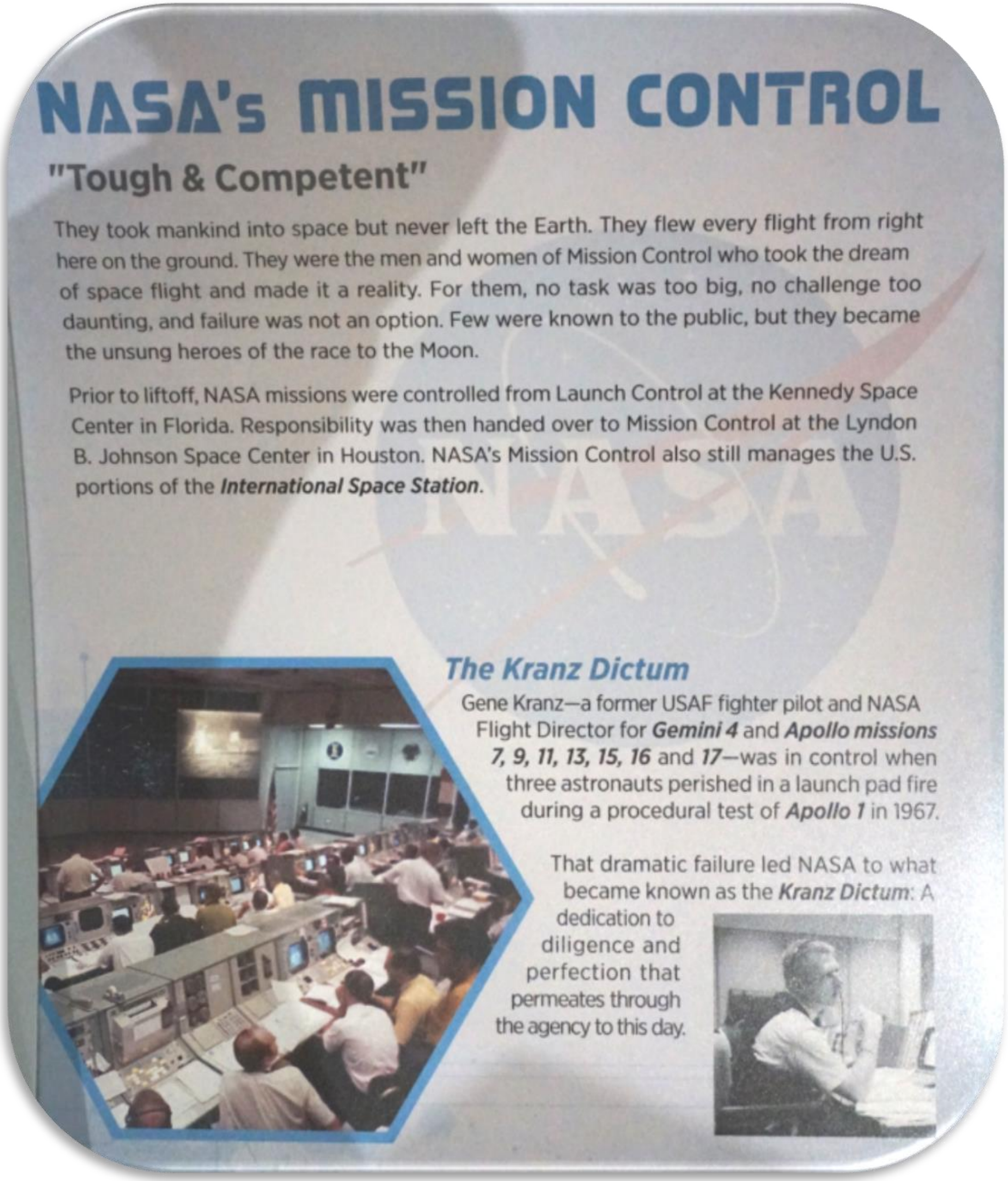
Space Gallery



NASA's MISSION CONTROL

"Tough & Competent"

They took mankind into space but never left the Earth. They flew every flight from right here on the ground. They were the men and women of Mission Control who took the dream of space flight and made it a reality. For them, no task was too big, no challenge too daunting, and failure was not an option. Few were known to the public, but they became the unsung heroes of the race to the Moon.

Prior to liftoff, NASA missions were controlled from Launch Control at the Kennedy Space Center in Florida. Responsibility was then handed over to Mission Control at the Lyndon B. Johnson Space Center in Houston. NASA's Mission Control also still manages the U.S. portions of the ***International Space Station***.

The Kranz Dictum

Gene Kranz—a former USAF fighter pilot and NASA Flight Director for ***Gemini 4*** and ***Apollo missions 7, 9, 11, 13, 15, 16*** and ***17***—was in control when three astronauts perished in a launch pad fire during a procedural test of ***Apollo 1*** in 1967.

That dramatic failure led NASA to what became known as the ***Kranz Dictum***: A dedication to diligence and perfection that permeates through the agency to this day.

Key Points: Primary Controllers:

- **DIRECTOR OF FLIGHT OPERATIONS (The Boss),**
- **FLIGHT** (Flight Director, Boss #2),
- **PROCEDURES** ("GO/NO GO" decisions),
- **CAPCOM** (Capsule Communicator),
- **BOOSTER** (Booster Systems Engineer),
- **SURGEON** (Flight Surgeon),
- **RETRO** (Retrofire Officer),
- **FIDO** (Flight Dynamics Officer),
- **GUIDO** (Guidance Officer),
- **EECOM** (Electrical, Environmental and Consumables Manager),
- **NETWORK** (Controlled worldwide tracking stations and ships).
- **INCO** (Instrumentation and Communications Officer),
- **CONTROL** (Lunar Module Control)
- **GNC** (Guidance, Navigation & Control)
- **RADAR** (Landing Radar Controller)

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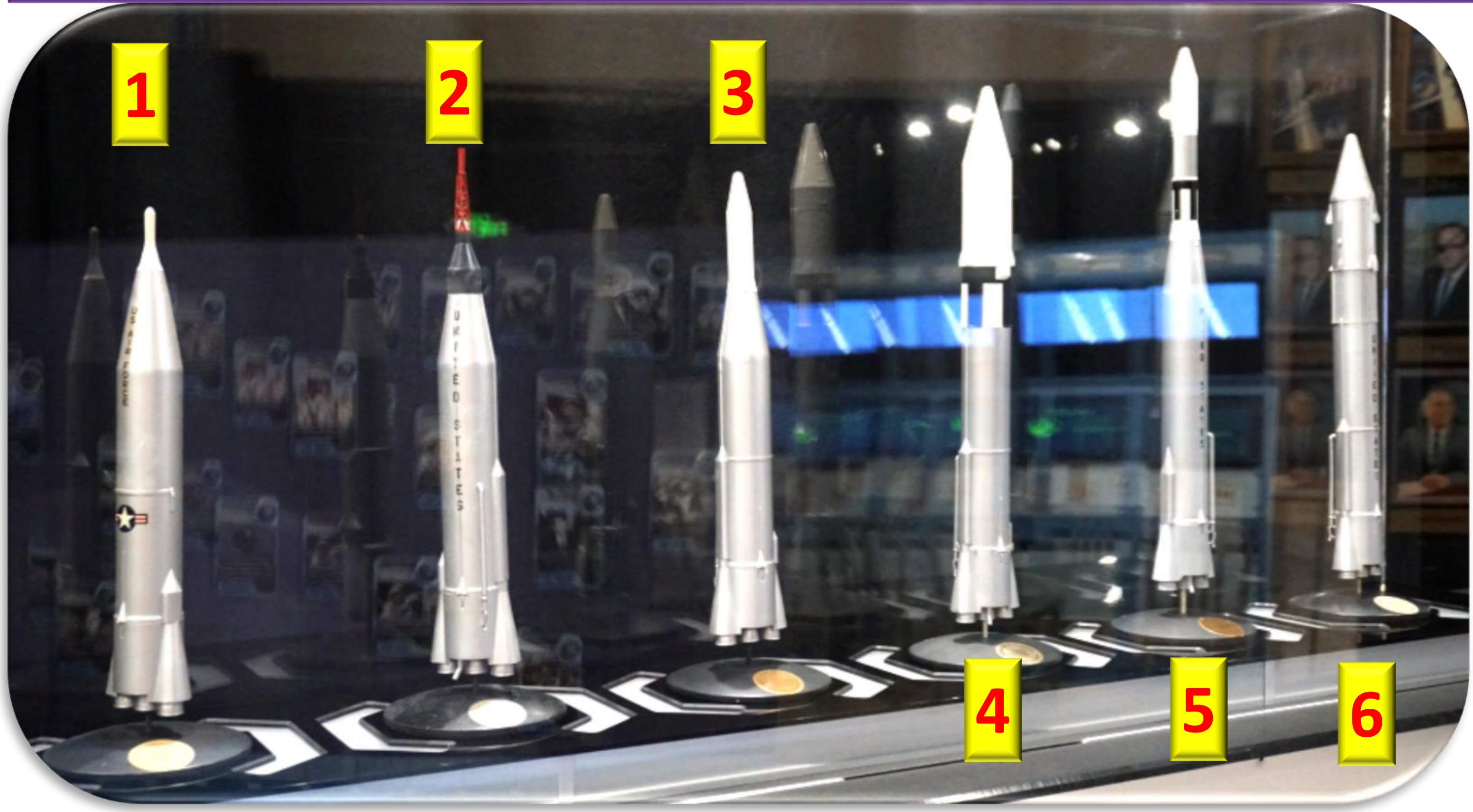
Space Gallery



First Launch: 1959

Key Points: **Atlas launch vehicles**. An **evolution of San Diego built Atlas missiles and space launch vehicles** (same missile; different payloads). Program originated with a liquid fueled SM-65 Atlas rocket 1. Atlas intercontinental ballistic missile (ICBM) program initiated late 1950s under the **Convair Division of General Dynamics**. **All Atlas vehicles had 3 engines, called "stage-and-a-half" design**; two outboard engines & structure were jettisoned during ascent, center sustainer engine (with fuel tanks and structure) remained through propellant depletion and shutdown.

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Space Gallery

1

CONVAIR DIVISION OF GENERAL DYNAMICS CORPORATION
ATLAS
USAF
ICBM

2

CONVAIR DIVISION
ATLAS-MERCURY
(MAN-IN-SPACE)
FOR NASA
GENERAL DYNAMICS CORPORATION

3

CONVAIR DIVISION
SLV-3A
ATLAS SPACE LAUNCH
VEHICLE
WITH AGENA
GENERAL DYNAMICS CORPORATION

4

GENERAL DYNAMICS
ATLAS-CENTAUR
INTERPLANETARY
SPACE VEHICLE
FOR NASA
ASTRONAUTICS

5

CONVAIR DIVISION
SLV-3A
ATLAS SPACE LAUNCH
VEHICLE
WITH AGENA
GENERAL DYNAMICS CORPORATION

6

GENERAL DYNAMICS
ATLAS-CENTAUR
INTERPLANETARY
SPACE VEHICLE
FOR NASA
ASTRONAUTICS

Key Points: Atlas missiles saw only brief ICBM service; taken off operational status 1965. In 1962/63, **Atlas launched first 4 US astronauts into Earth orbit** (following two Redstone suborbital launches). Atlas-Agena & Atlas-Centaur satellite launch vehicles derived directly from the original Atlas. **Atlas-Centaur** evolved into the Atlas II, which **launched 63 times** between 1991 and 2004. Succeeding **Atlas III, launched 6 times** between 2000 and 2005. **Atlas V is still in service**, with launches planned into the 2020s.

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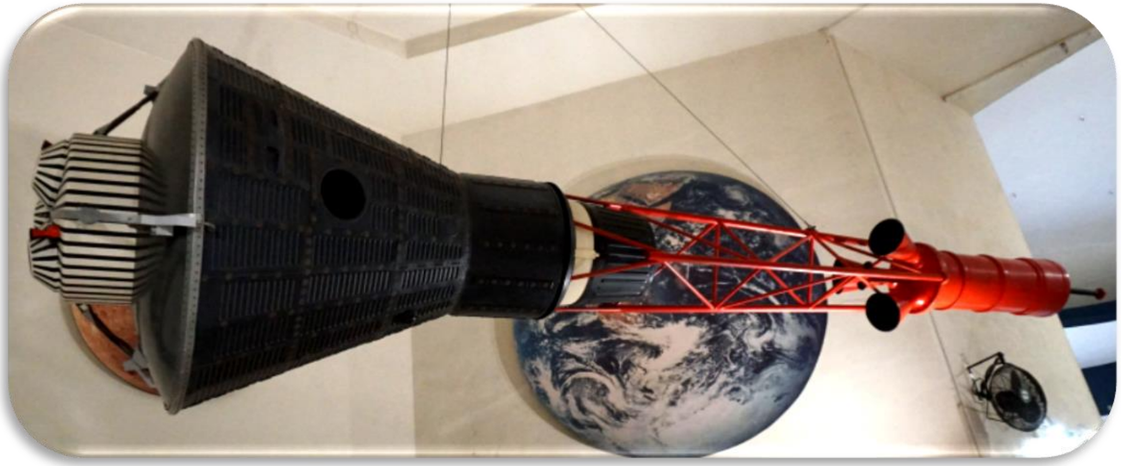
Space Gallery



1st flight: 1961

Key Points: Mercury Spacecraft (Full sized model) **America's first human space craft;** 1959 thru 1963. **Goal: Put an astronaut in space/earth orbit and return safely.**

Mission	Call-sign	Pilot	First's	Launch	Duration	Orbits
Mercury-Redstone 3	*Freedom 7*	**Alan Shepard**	1st US in Space	May 5, 1961	15m 22s	0
Mercury-Redstone 4	*Liberty Bell 7*	**Virgil "Gus" Grissom**		July 21, 1961	15m 37s	0
Mercury-Atlas 6	*Friendship 7*	**John Glenn**	1st US to Orbit	Feb 20, 1962	4h 55m 23s	3
Mercury-Atlas 7	*Aurora 7*	**Scott Carpenter**		May 24, 1962	4h 56m 5s	3
Mercury-Atlas 8	*Sigma 7*	**Walter Schirra**		Oct 3, 1962	9h 13m 15s	6
Mercury-Atlas 9	*Faith 7*	**Gordon "Gordo" Cooper**		May 15, 1963	34h 19m 49s	22
Grounded 1962 Reinstated 1972		**Donald "Deke" Slayton**				

This: A full sized model of **Sigma 7**, the third Mercury mission to orbit the Earth (Oct 3, 1962), with **Walter "Wally" Schirra**, a San Diego resident.

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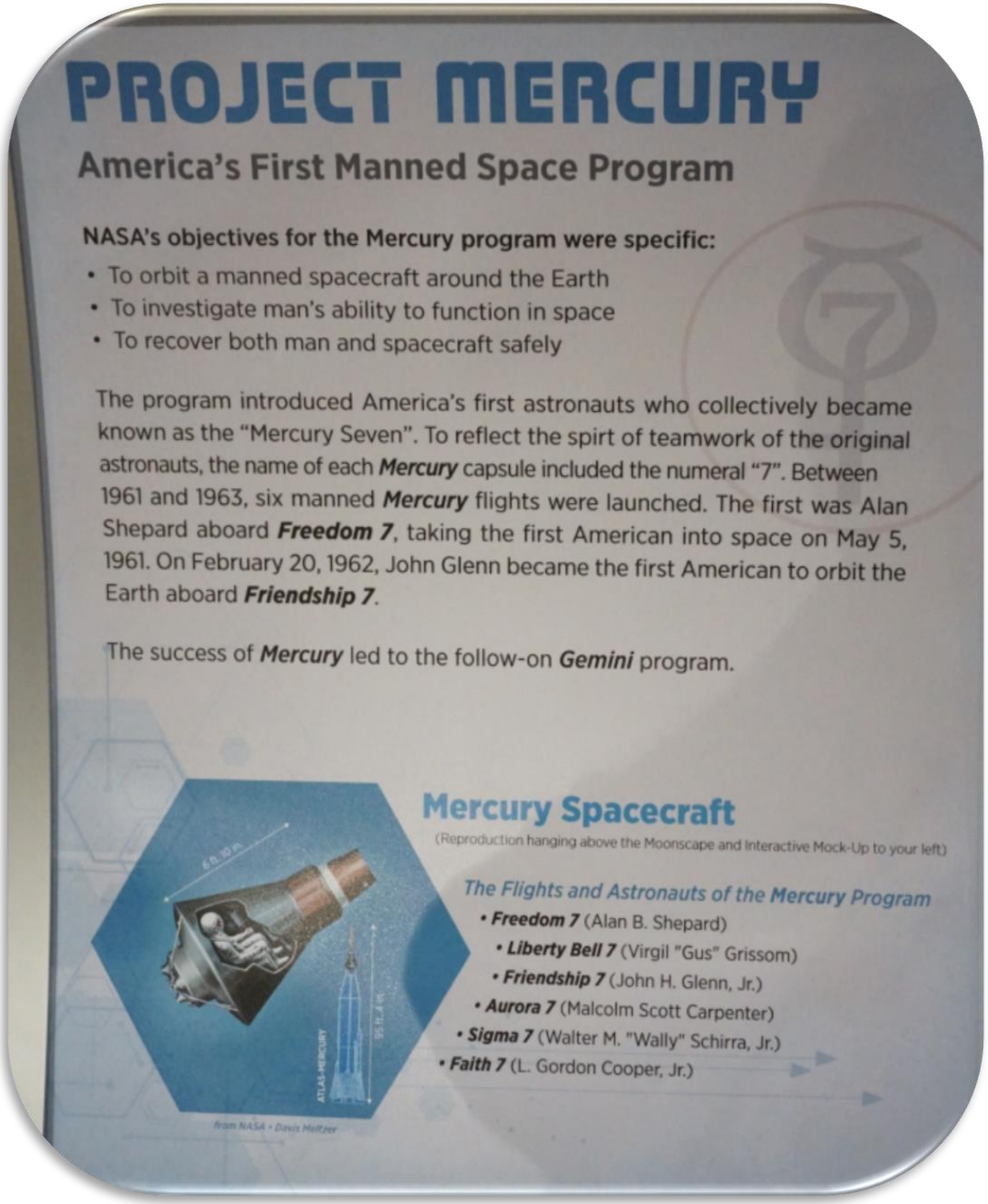
Space Gallery



PROJECT MERCURY

America's First Manned Space Program

NASA's objectives for the Mercury program were specific:

- To orbit a manned spacecraft around the Earth
- To investigate man's ability to function in space
- To recover both man and spacecraft safely

The program introduced America's first astronauts who collectively became known as the "Mercury Seven". To reflect the spirt of teamwork of the original astronauts, the name of each ***Mercury*** capsule included the numeral "7". Between 1961 and 1963, six manned ***Mercury*** flights were launched. The first was Alan Shepard aboard ***Freedom 7***, taking the first American into space on May 5, 1961. On February 20, 1962, John Glenn became the first American to orbit the Earth aboard ***Friendship 7***.

The success of ***Mercury*** led to the follow-on ***Gemini*** program.

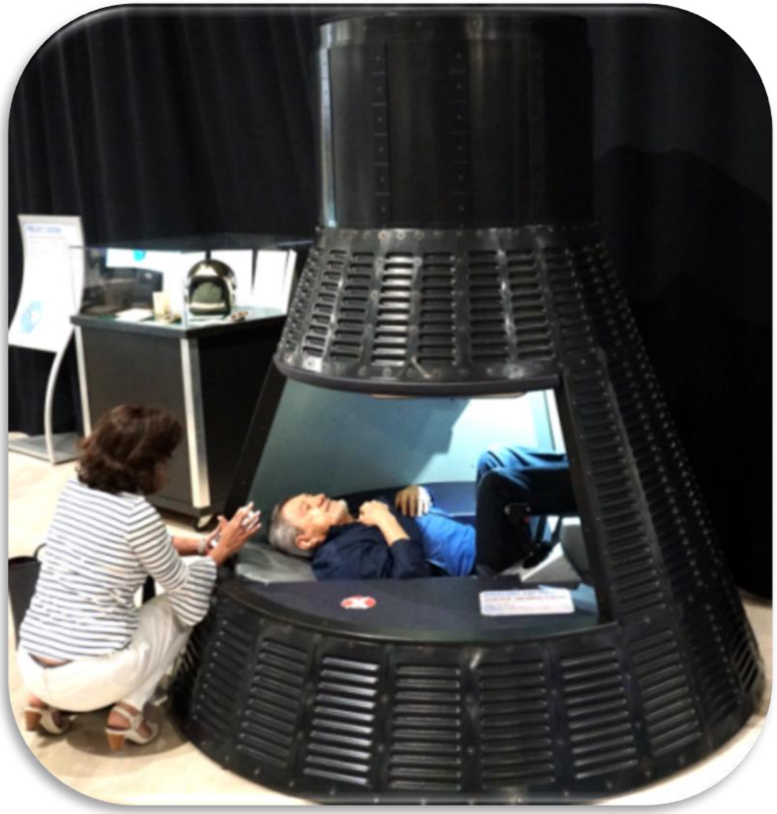
Mercury Spacecraft

(Reproduction hanging above the Moonscape and Interactive Mock-Up to your left)

The Flights and Astronauts of the Mercury Program

- ***Freedom 7*** (Alan B. Shepard)
- ***Liberty Bell 7*** (Virgil "Gus" Grissom)
- ***Friendship 7*** (John H. Glenn, Jr.)
- ***Aurora 7*** (Malcolm Scott Carpenter)
- ***Sigma 7*** (Walter M. "Wally" Schirra, Jr.)
- ***Faith 7*** (L. Gordon Cooper, Jr.)

6 ft. 10 in.
95 ft. 4 in.
ATLAS-MERCURY
from NASA • Davis Meltzer



This: A Mock-up of a Mercury capsule to allow guests to experience the actual size of the interior. Built by SDASM volunteers.

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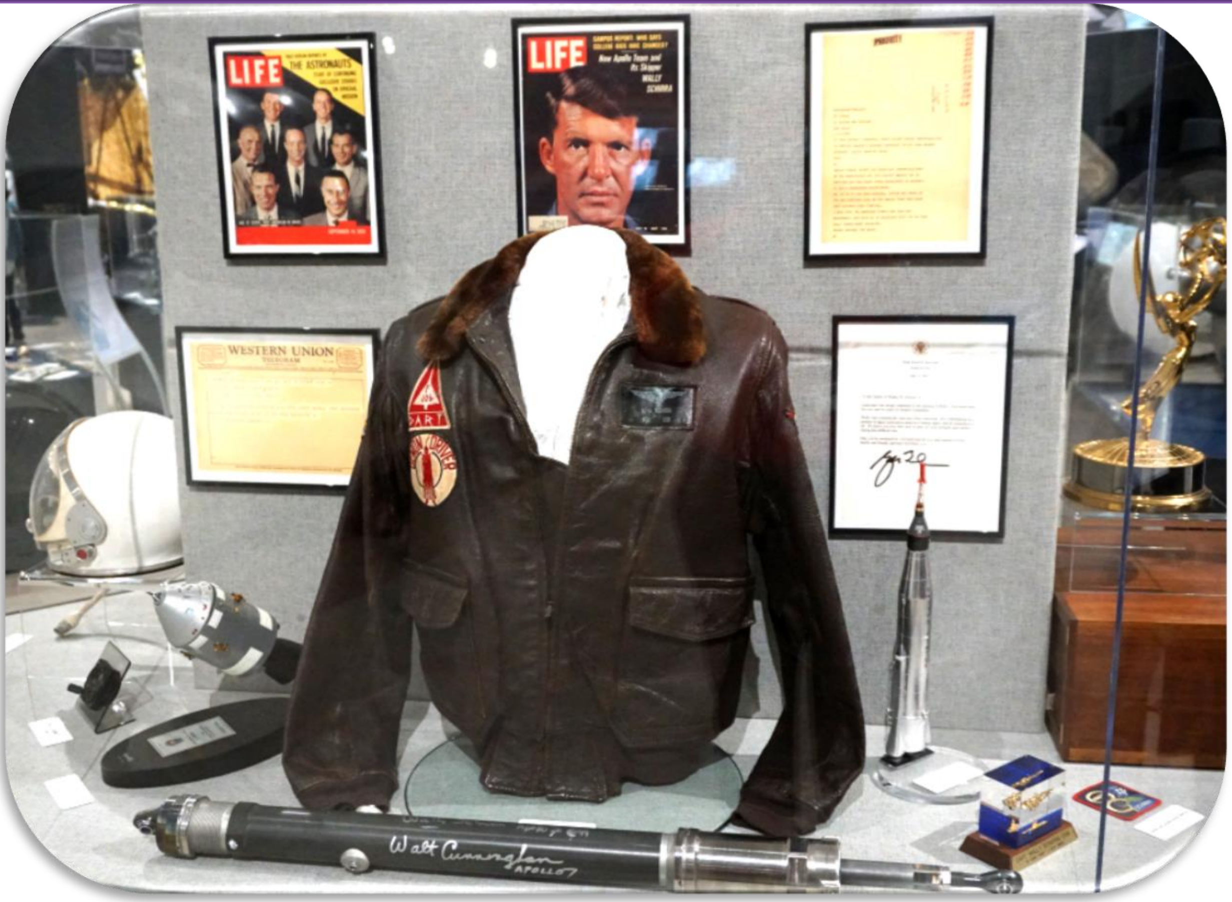
Space Gallery


LIFE
THE ASTRONAUTS
LIFE
WALLY SCHIRRA
WESTERN UNION
Walt Cunningham
APOLLO 7

Key Points: **Walter Schirra Memorabilia Display**. Naval Aviator and **original Mercury 7 Astronaut**. 5th American and **9th human in space**. First astronaut to go into space three times, and **only astronaut to have flown in the Mercury, Gemini, and Apollo** space programs. Schirra joined Walter Cronkite as **co-anchor for NASA's Apollo 11 through 17 moon landing missions**.

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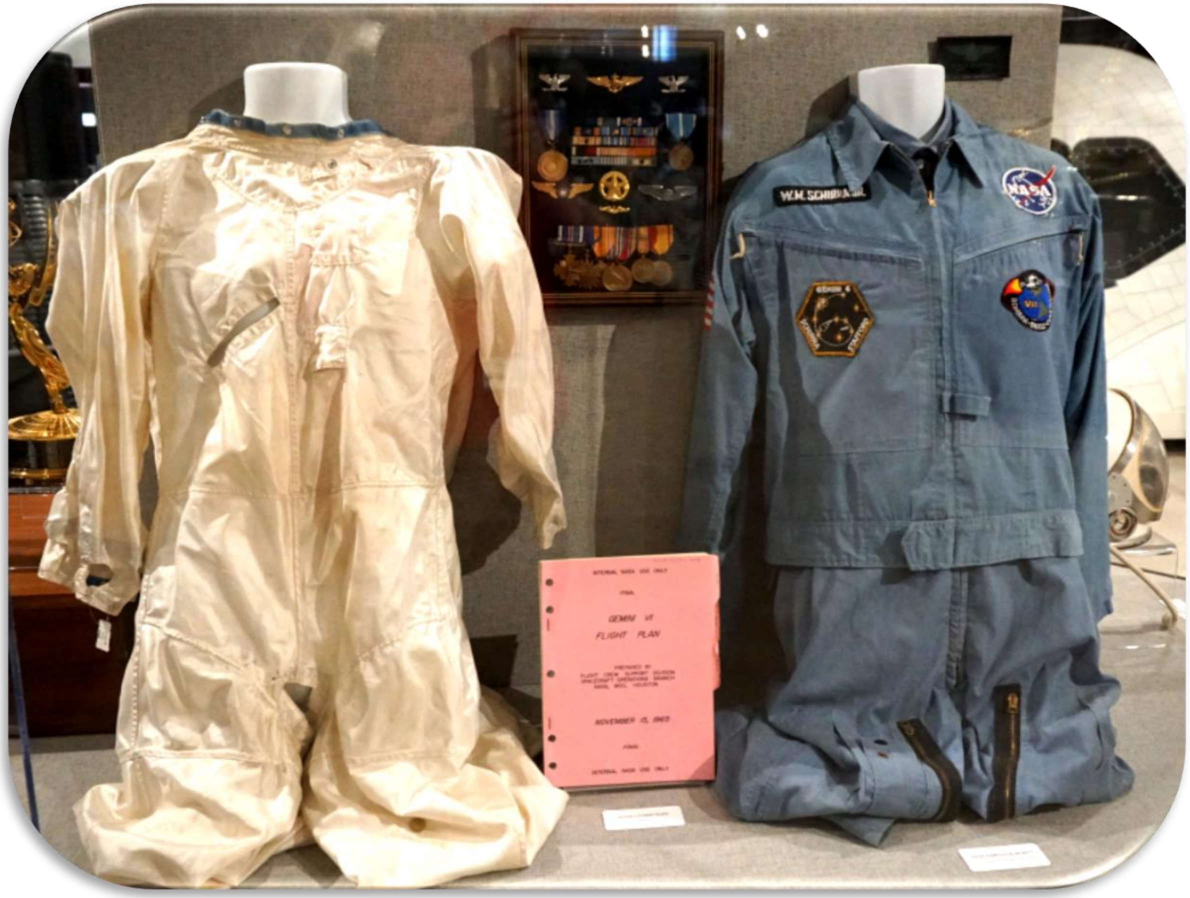
Space Gallery



Key Points: **Schirra** flew the six-orbit, Mercury-Atlas 8 mission, in *Sigma 7*. In the Gemini program, he **achieved the first space rendezvous**, station-keeping his Gemini 6A spacecraft within 1 foot of the sister Gemini 7 spacecraft in December 1965. In October 1968, he **commanded Apollo 7**, an 11-day low Earth orbit shakedown test of the three-man Apollo Command/Service Module and the **first crewed launch for the Apollo program**.

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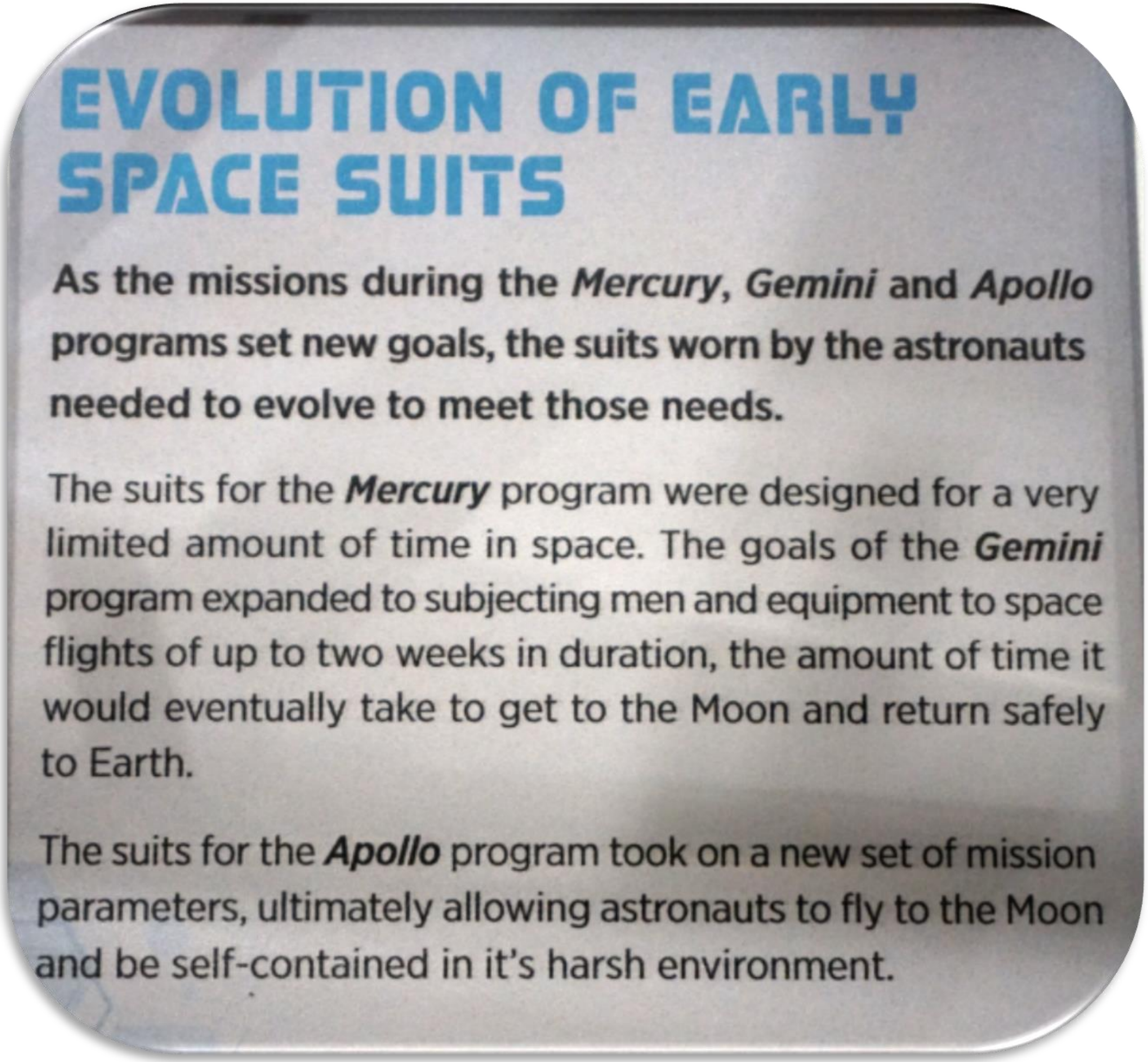

EVOLUTION OF EARLY SPACE SUITS

As the missions during the *Mercury*, *Gemini* and *Apollo* programs set new goals, the suits worn by the astronauts needed to evolve to meet those needs.

The suits for the ***Mercury*** program were designed for a very limited amount of time in space. The goals of the ***Gemini*** program expanded to subjecting men and equipment to space flights of up to two weeks in duration, the amount of time it would eventually take to get to the Moon and return safely to Earth.

The suits for the ***Apollo*** program took on a new set of mission parameters, ultimately allowing astronauts to fly to the Moon and be self-contained in it's harsh environment.

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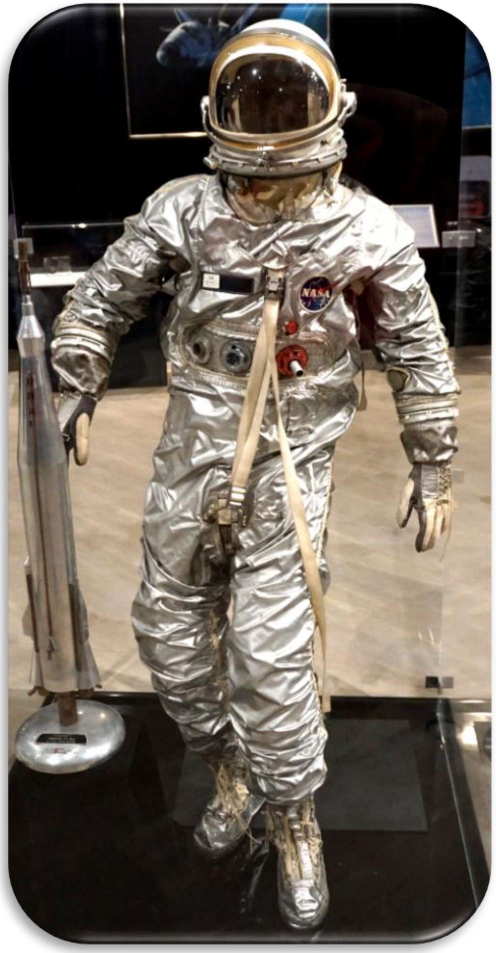
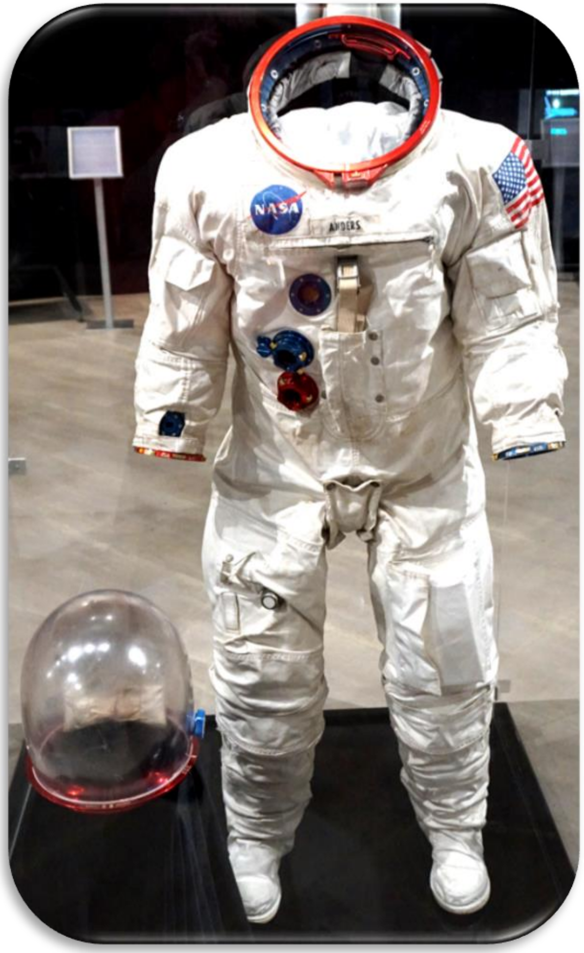
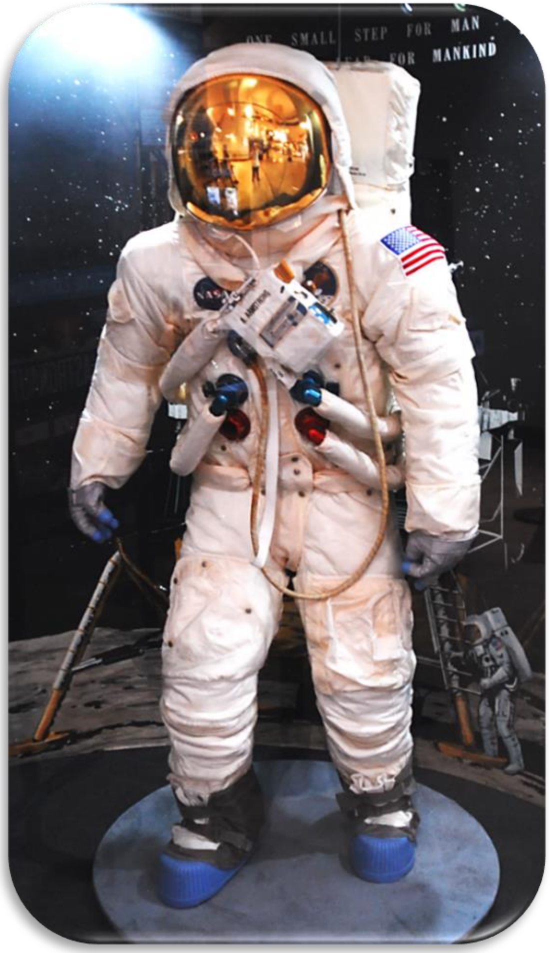


Early Gemini suit


NASA
ANDERS

Apollo Training suit


STEP FOR MAN
MANKIND

Apollo self-contained suit

Key Points: **Evolution of space suits.**

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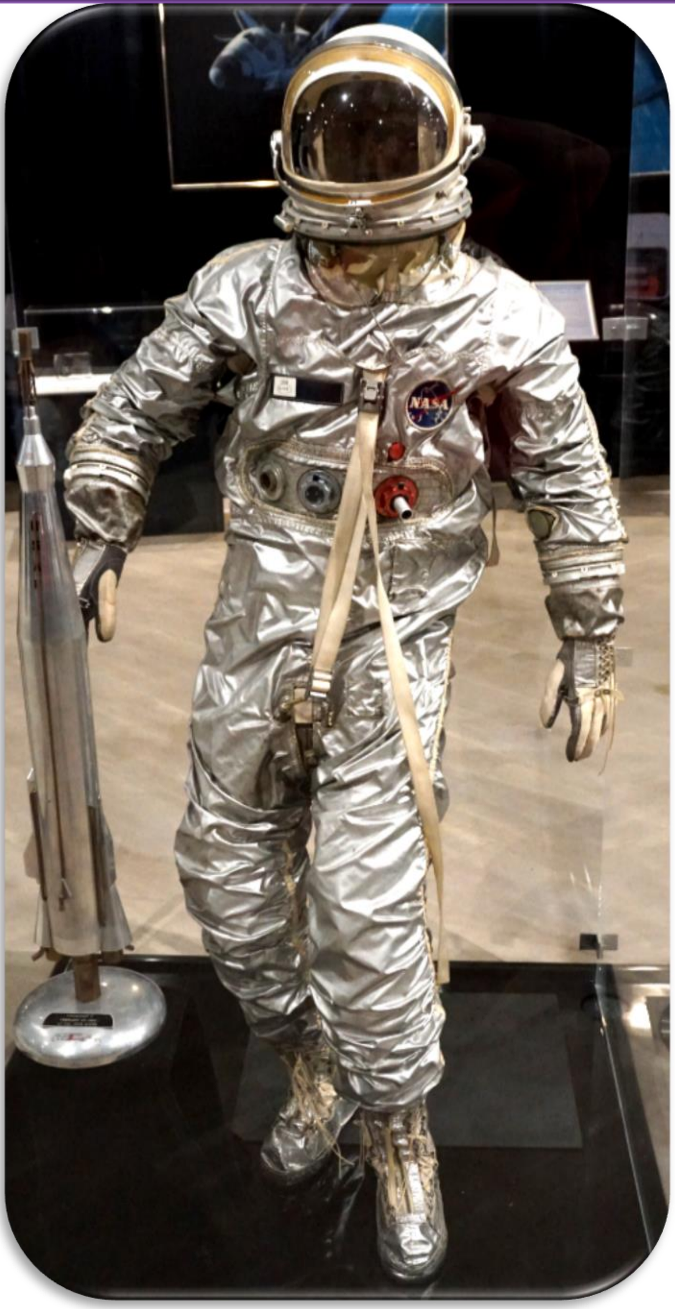
Space Gallery



Key Points: Early Gemini G-2C test spacesuit (Original) . First true 'space' suits built by **David Clark** and **BF Goodrich**, were based upon **A-12/SR-71 Blackbird flight suits**. This suit differs from those actually flown on Gemini, but most notably the suit has a silver cover-layer similar to Mercury program spacesuits. Initially, suit engineers thought that the silver coating's reflectivity would be adequate to protect astronauts from heat fluctuations and solar radiation during spacewalks. Subsequent tests determined that a layered, white, fire resistant cover-layer performed better.

The space suits developed for the Gemini were the first developed for long-duration manned spaceflight and extravehicular activity.

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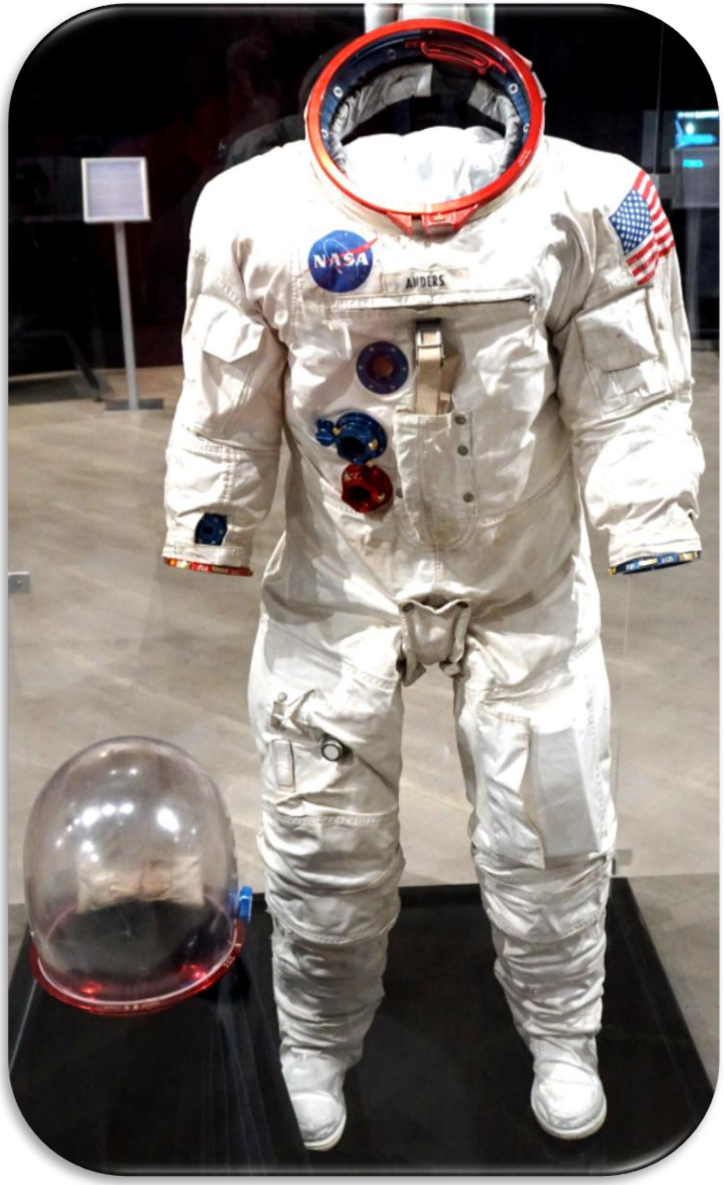
Space Gallery



Key Points: William Alison "Bill" Anders Space Suit (Original). Made by ILC Industries, Inc.. Maj Gen, USAF, Ret.; electrical engineer, nuclear engineer, NASA astronaut, and businessman. December, 1968, **Apollo 8, Bill Anders**, **Frank Borman,** and **Jim Lovell**, are the first humans to have left Earth orbit and traveled to the Moon.

Extra Info: Anders took the celebrated photograph of ***Earthrise*** *(below)*. **Anders** graduated St. Martin's Academy and Grossmont High School in La Mesa, California.

This: One of **Anders** training space suits.

Earthrise Photo

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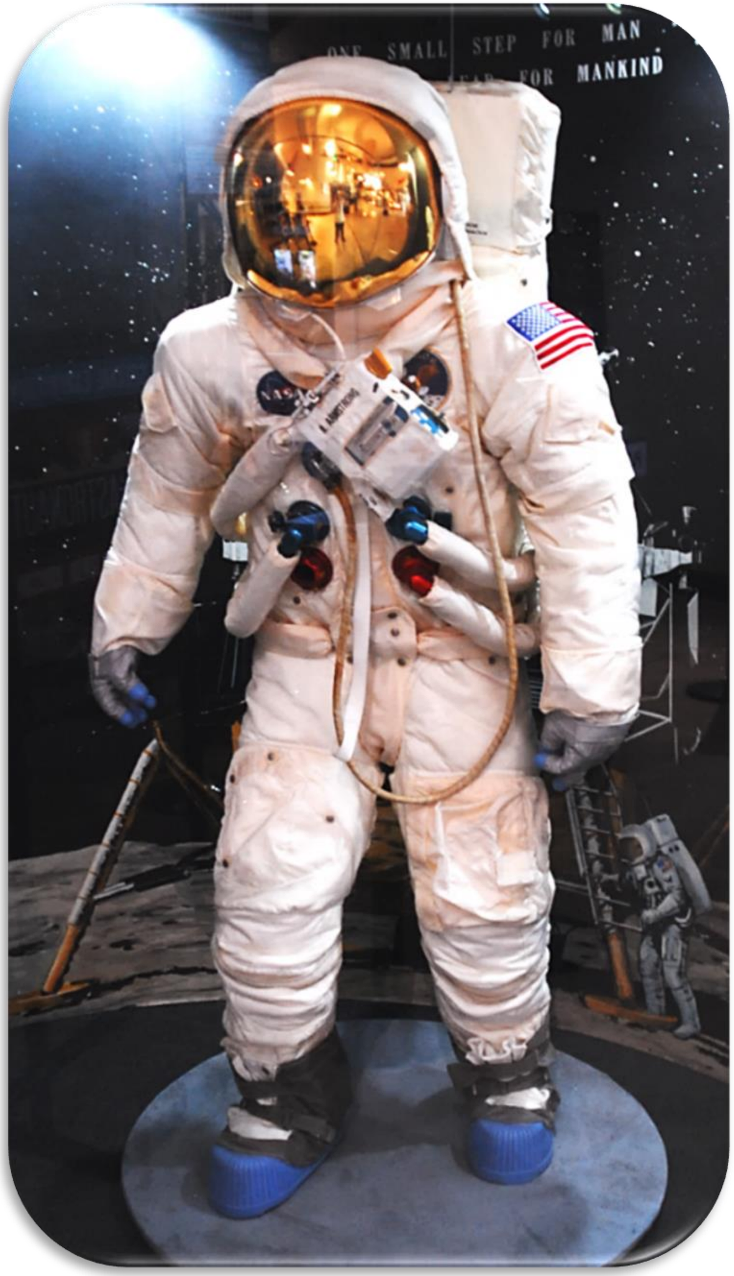

Key Points: Apollo Space Suit (Original). Built by ILC Dover (Suit) and Hamilton Standard (Life support). Type used by **Apollo 7 thru 14 astronauts. 13 layers of material**; an inner cooling garment (2 layers), pressure garment (2 layers), thermal micrometeoroid garment (8 layers) and outer cover (1 layer).

Self contained (oxygen, water, food bar, lights, cameras, batteries, air conditioner and communications) for exploration on the moon.

Life support for 6 hours, + 30 min reserve.

Weight: 200 lbs on earth, 33 lbs on moon.

Note: Suits for Apollo 15 – 17 carried an hour more life support for use with the lunar rover missions. All the space suits were pressurized to 25% of earth's pressure making them very fatiguing to work in.

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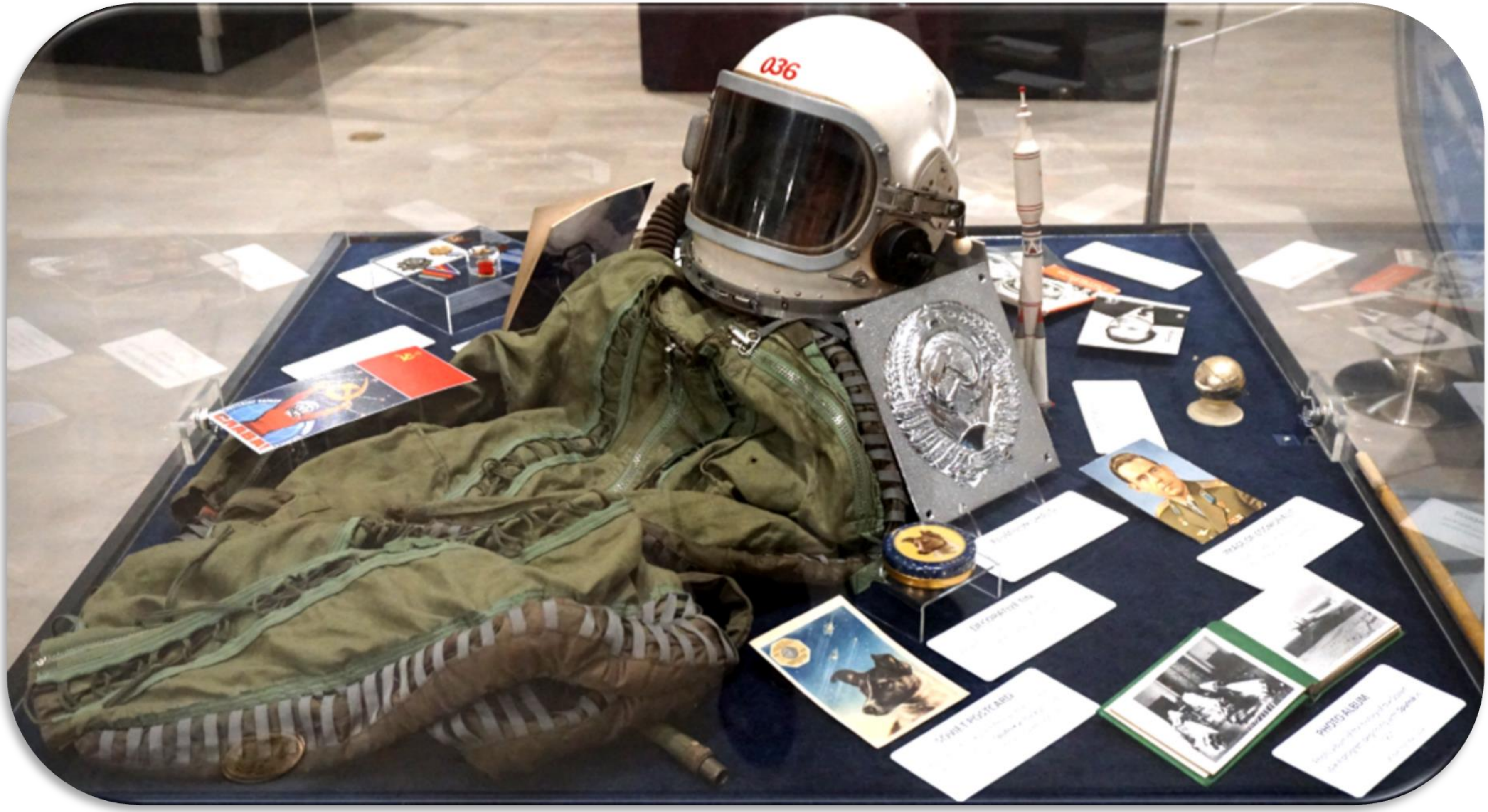
Space Gallery



Key Points: **Early Russian space suit and Memorabilia from the Russian Space Program**. Photo album of Soviet space program, pictures of Cosmonauts, Soviet rocket model, Soviet space emblem, helmet, medals, suit.

Space Gallery

Key Points: **Apollo Oxygen Tank (Original spare).** Three identical spherical tanks each held a "slush" of liquid oxygen and were mounted in all Apollo Service Modules. They provided oxygen to power cells in the SM and the crew in the Command Module during the enroute flight to and from the Moon. **Apollo 13's** #2 oxygen tank (identical to this one) had been installed in Apollo 10, however it was damaged and was replaced. After an exterior inspection, the damaged tank was later installed in Apollo 13. **All components were upgraded except the heater thermostatic switches, which were overlooked. This resulted in the tank exploding during Apollo 13's flight to the moon.**

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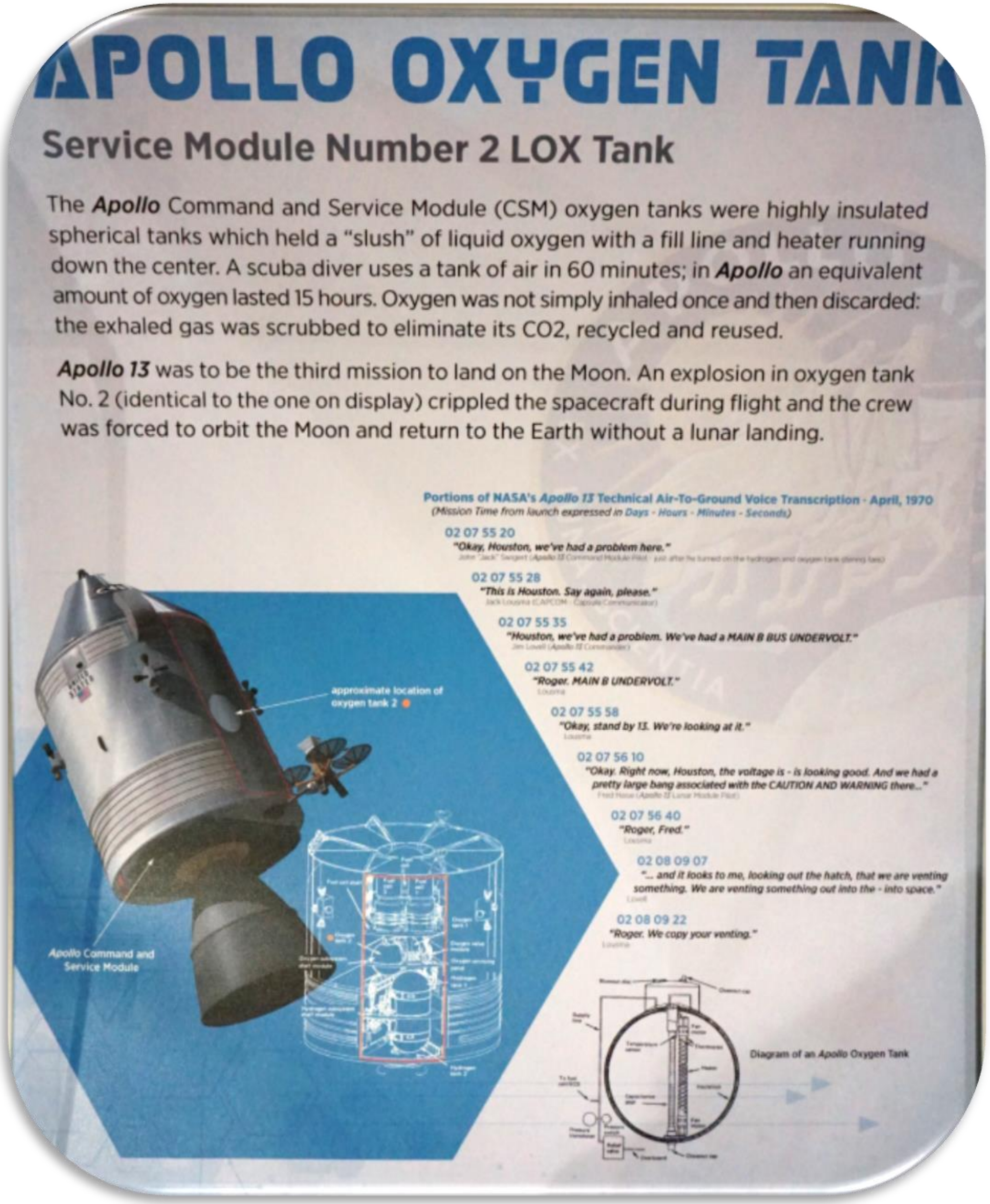

APOLLO OXYGEN TANK

Service Module Number 2 LOX Tank

The *Apollo* Command and Service Module (CSM) oxygen tanks were highly insulated spherical tanks which held a "slush" of liquid oxygen with a fill line and heater running down the center. A scuba diver uses a tank of air in 60 minutes; in *Apollo* an equivalent amount of oxygen lasted 15 hours. Oxygen was not simply inhaled once and then discarded: the exhaled gas was scrubbed to eliminate its CO2, recycled and reused.

Apollo 13 was to be the third mission to land on the Moon. An explosion in oxygen tank No. 2 (identical to the one on display) crippled the spacecraft during flight and the crew was forced to orbit the Moon and return to the Earth without a lunar landing.

Portions of NASA's *Apollo 13* Technical Air-To-Ground Voice Transcription - April, 1970
(Mission Time from launch expressed in Days - Hours - Minutes - Seconds)

02 07 55 20
"Okay, Houston, we've had a problem here."
John "Jack" Swigert (*Apollo 13* Command Module Pilot - just after he turned on the hydrogen and oxygen tank stirring fans)

02 07 55 28
"This is Houston. Say again, please."
Jack Lousma (CAPCOM - Capsule Communicator)

02 07 55 35
"Houston, we've had a problem. We've had a MAIN B BUS UNDERVOLT."
Jim Lovell (*Apollo 13* Commander)

02 07 55 42
"Roger. MAIN B UNDERVOLT."
Lousma

02 07 55 58
"Okay, stand by 13. We're looking at it."
Lousma

02 07 56 10
"Okay. Right now, Houston, the voltage is - is looking good. And we had a pretty large bang associated with the CAUTION AND WARNING there..."
Fred Haise (*Apollo 13* Lunar Module Pilot)

02 07 56 40
"Roger, Fred."
Lousma

02 08 09 07
"... and it looks to me, looking out the hatch, that we are venting something. We are venting something out into the - into space."
Lovell

02 08 09 22
"Roger. We copy your venting."
Lousma

approximate location of oxygen tank 2 ●

Apollo Command and Service Module

Diagram of an *Apollo* Oxygen Tank

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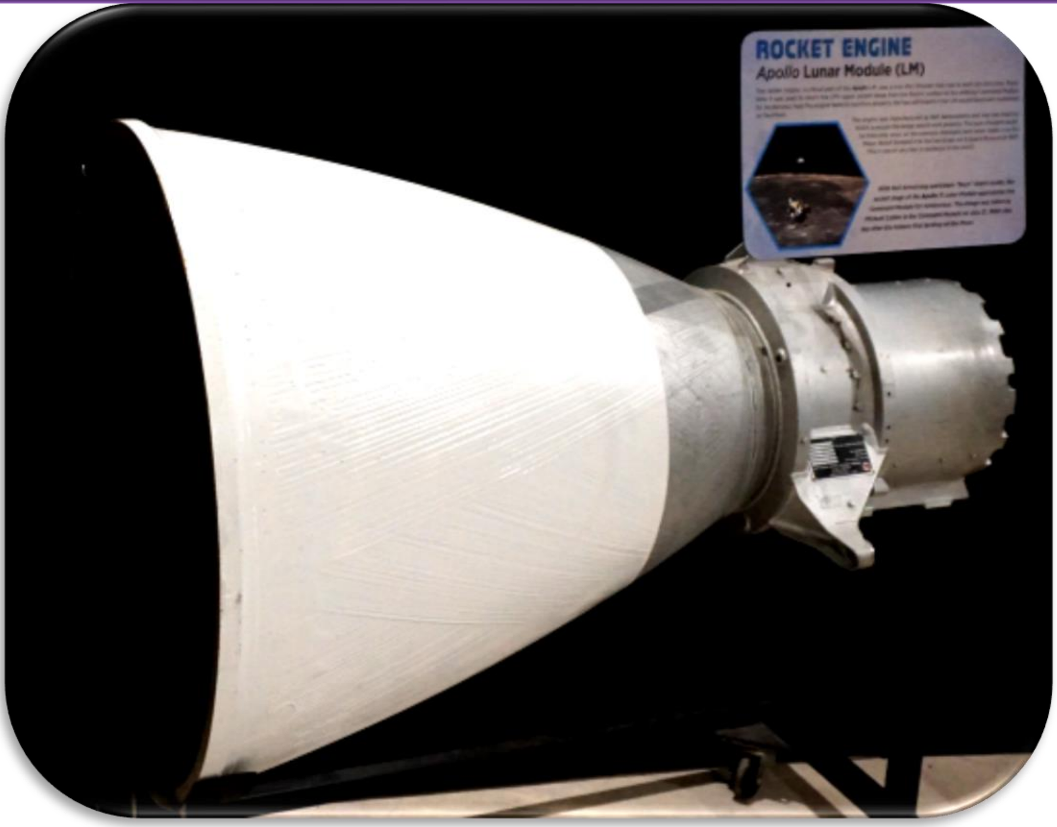
Space Gallery

*

***Note:* Hypergolic propellants** - They spontaneously ignite when they come into contact with each other.

1st Run: 1964

1st Run in space: 1969 (Apollo 9)

Key Points:

Ascent Propulsion System (Original Spare) or **lunar module ascent engine** (**LMAE**) is a fixed-thrust hypergolic * rocket engine developed by **Bell Aerosystems** (and based on the RM-81 Agena engine), for use in the Apollo **Lunar Module ascent stage**. It used **Aerozine-50 fuel**, and **Nitrogen Tetroxide oxidizer** as hypergolic propellants*.

This: This type engine had to fire the first time, every time or the crew would be stranded on the Moon. This particular engine did not make it to the Moon and **is one of very few in existence**. Donated by NASA to the SDASM in 1997.

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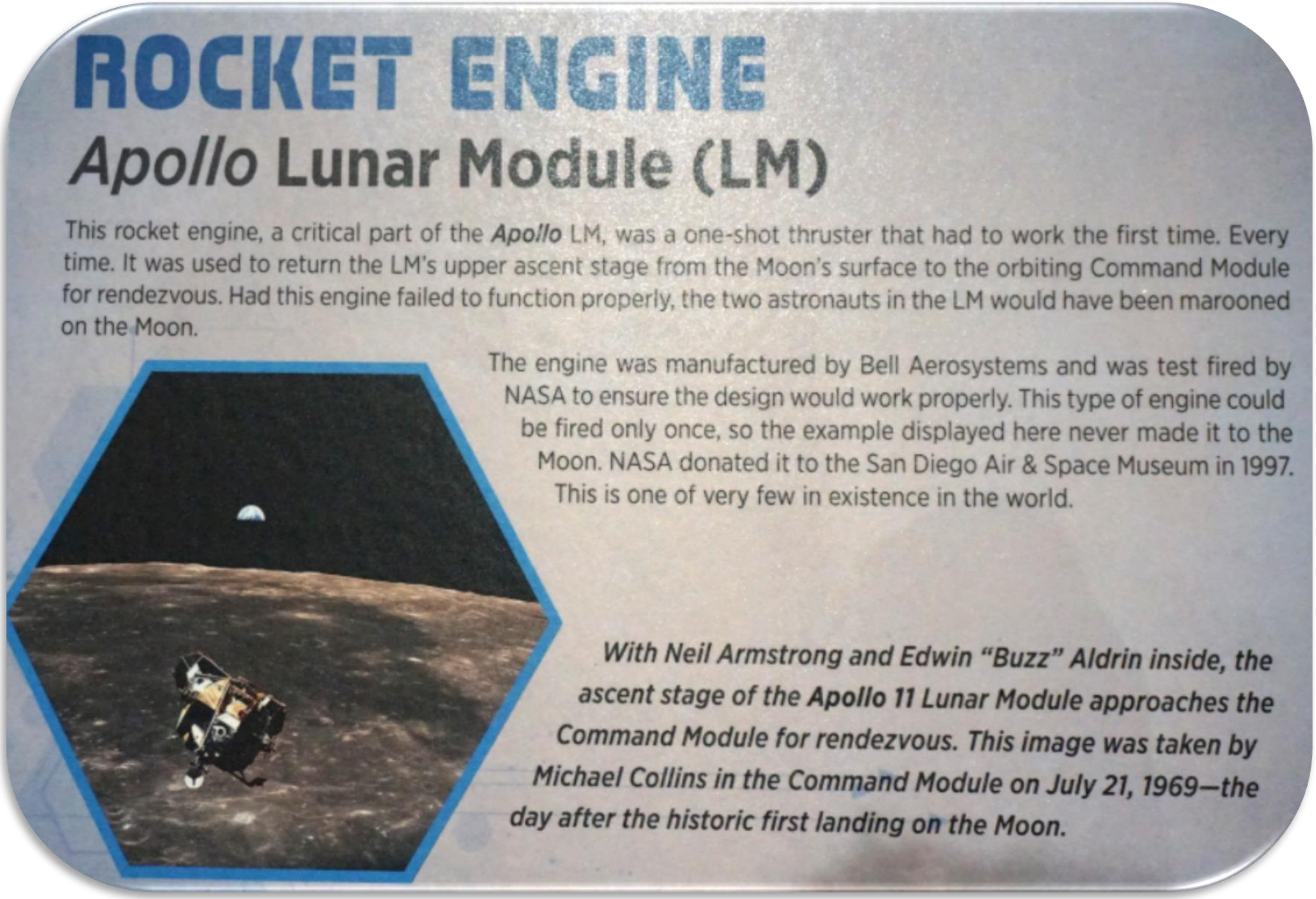
Space Gallery



ROCKET ENGINE

Apollo Lunar Module (LM)

This rocket engine, a critical part of the ***Apollo*** LM, was a one-shot thruster that had to work the first time. Every time. It was used to return the LM's upper ascent stage from the Moon's surface to the orbiting Command Module for rendezvous. Had this engine failed to function properly, the two astronauts in the LM would have been marooned on the Moon.

The engine was manufactured by Bell Aerosystems and was test fired by NASA to ensure the design would work properly. This type of engine could be fired only once, so the example displayed here never made it to the Moon. NASA donated it to the San Diego Air & Space Museum in 1997. This is one of very few in existence in the world.

*With Neil Armstrong and Edwin "Buzz" Aldrin inside, the ascent stage of the **Apollo 11** Lunar Module approaches the Command Module for rendezvous. This image was taken by Michael Collins in the Command Module on July 21, 1969—the day after the historic first landing on the Moon.*

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Space Gallery

Project Gemini – The bridge between Project Mercury and Project Apollo. Gemini missions 1 thru 12 (missions 1 & 2 were unmanned) developed and tested **crewed flight, extravehicular activity, rendezvous/docking and spacecraft control**. Launch vehicle(s): **Atlas-Agena**; **Titan II** Gemini Launch Vehicle (GLV).

UNITED STATES

1st flight: 1965

Key Points: Gemini Spacecraft (Full sized Model) **-** 1961 to 1966; NASA's second manned spaceflight program saw **10 manned Gemini missions** (2 astronauts per mission for up to 14 days) orbiting the Earth. In 20 months, 16 Gemini astronauts spent 1,940 total hours in space. Gemini favorably answered the question: **Could astronauts rendezvous and dock in space, walk and work in space and endure a two week mission**.

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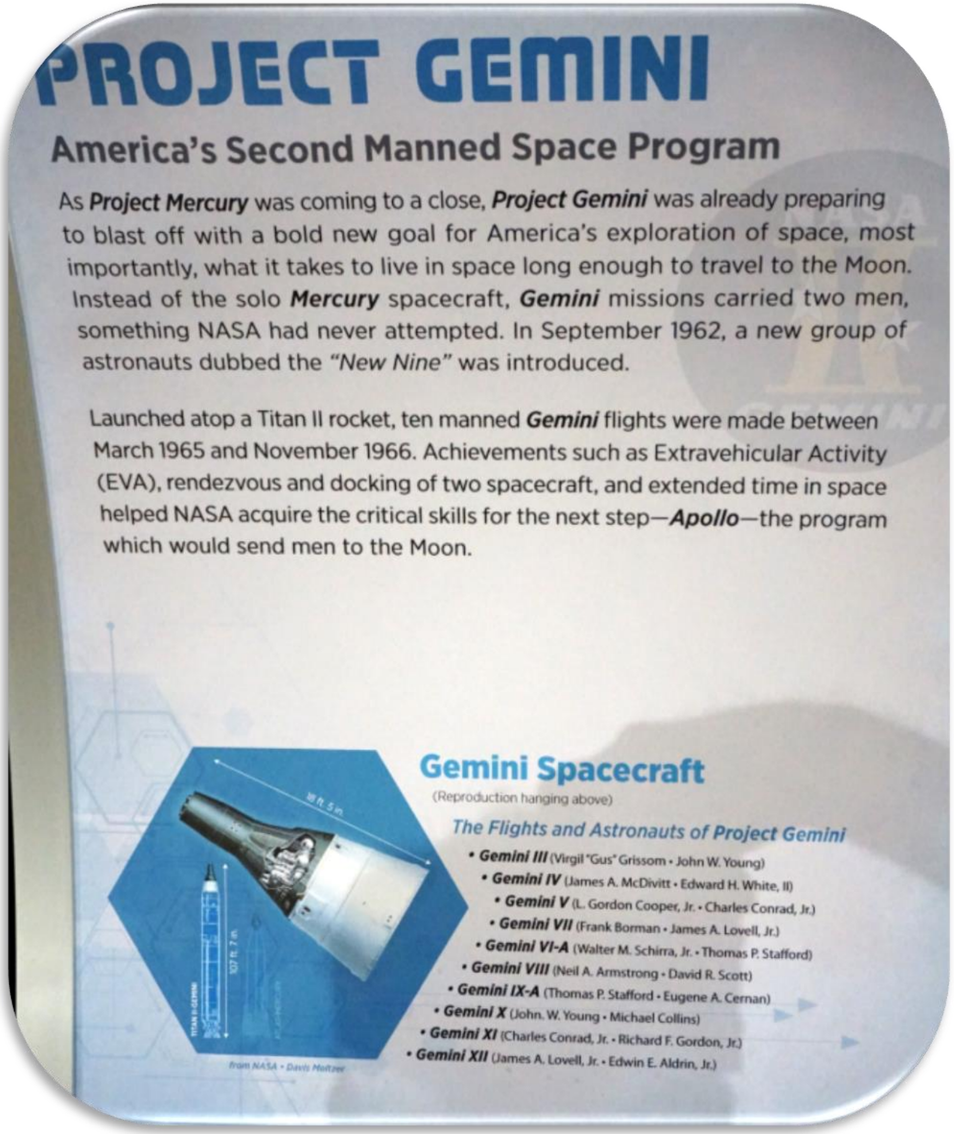
Space Gallery



PROJECT GEMINI

America's Second Manned Space Program

As ***Project Mercury*** was coming to a close, ***Project Gemini*** was already preparing to blast off with a bold new goal for America's exploration of space, most importantly, what it takes to live in space long enough to travel to the Moon. Instead of the solo ***Mercury*** spacecraft, ***Gemini*** missions carried two men, something NASA had never attempted. In September 1962, a new group of astronauts dubbed the *"New Nine"* was introduced.

Launched atop a Titan II rocket, ten manned ***Gemini*** flights were made between March 1965 and November 1966. Achievements such as Extravehicular Activity (EVA), rendezvous and docking of two spacecraft, and extended time in space helped NASA acquire the critical skills for the next step—***Apollo***—the program which would send men to the Moon.

Gemini Spacecraft

(Reproduction hanging above)

The Flights and Astronauts of Project Gemini

- ***Gemini III*** (Virgil "Gus" Grissom • John W. Young)
- ***Gemini IV*** (James A. McDivitt • Edward H. White, II)
- ***Gemini V*** (L. Gordon Cooper, Jr. • Charles Conrad, Jr.)
- ***Gemini VII*** (Frank Borman • James A. Lovell, Jr.)
- ***Gemini VI-A*** (Walter M. Schirra, Jr. • Thomas P. Stafford)
- ***Gemini VIII*** (Neil A. Armstrong • David R. Scott)
- ***Gemini IX-A*** (Thomas P. Stafford • Eugene A. Cernan)
- ***Gemini X*** (John. W. Young • Michael Collins)
- ***Gemini XI*** (Charles Conrad, Jr. • Richard F. Gordon, Jr.)
- ***Gemini XII*** (James A. Lovell, Jr. • Edwin E. Aldrin, Jr.)

from NASA • Davis Meltzer

Mission, crew position	Astronaut	Date
Gemini 3 Command Pilot	Virgil "Gus" Grissom	March 23, 1965
Gemini 3 Pilot	John Young	March 23, 1965
Gemini 4 Command Pilot	James McDivitt	June 3-7, 1965
Gemini 4 Pilot	Ed White	June 3-7, 1965
Gemini 5 Command Pilot	Gordon Cooper	August 21-29, 1965
Gemini 5 Pilot	Charles "Pete" Conrad	August 21-29, 1965
Gemini 6A Command Pilot	Walter M. Schirra	December 15, 1965
Gemini 6A Pilot	Thomas P. Stafford	December 15, 1965
Gemini 7 Command Pilot	Frank Borman	December 4-18, 1965
Gemini 7 Pilot	Jim Lovell	December 4-18, 1965
Gemini 8 Command Pilot	Neil Armstrong	March 16-17, 1966
Gemini 8 Pilot	David Scott	March 16-17, 1966
Gemini 9A Command Pilot	Thomas P. Stafford	June 3-6, 1966
Gemini 9A Pilot	Eugene Cernan	June 3-6, 1966
Gemini 10 Command Pilot	John Young	July 18-21, 1966
Gemini 10 Pilot	Michael Collins	July 18-21, 1966
Gemini 11 Command Pilot	Charles "Pete" Conrad	September 12-15, 1966
Gemini 11 Pilot	Richard F Gordon	September 12-15, 1966
Gemini 12 Command Pilot	Jim Lovell	November 11-15, 1966
Gemini 12 Pilot	Edwin "Buzz" Aldrin	November 11-15, 1966

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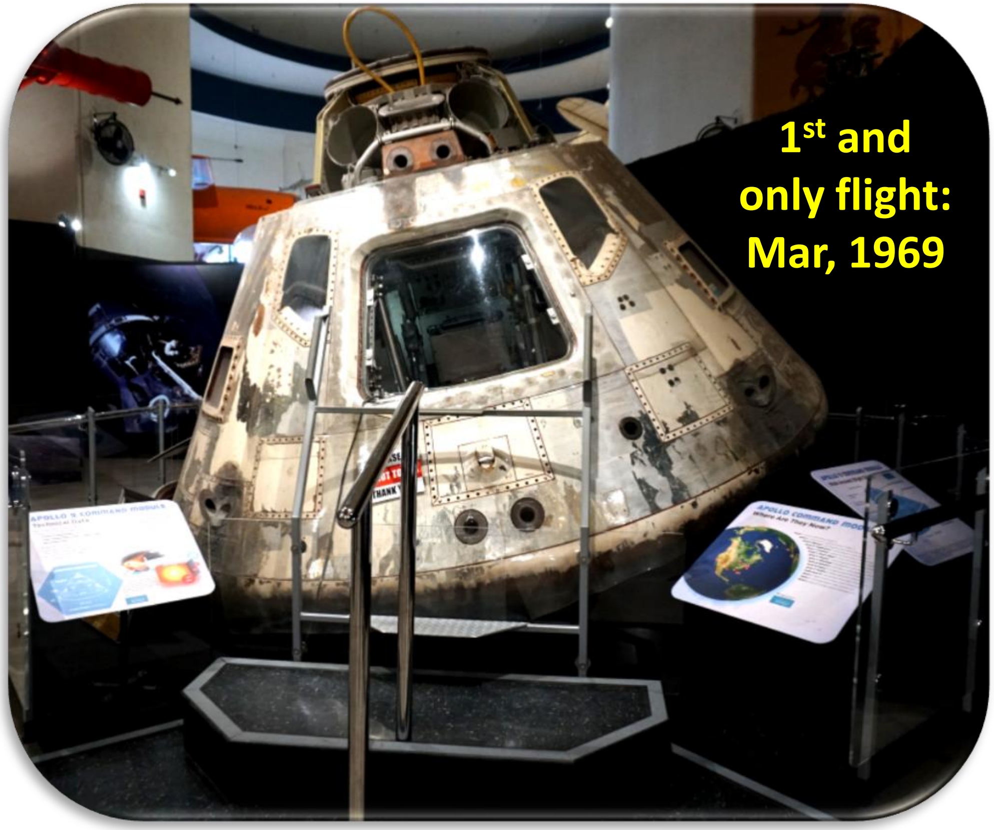

1st and only flight: Mar, 1969

APOLLO 9 COMMAND MODULE

APOLLO 9 COMMAND MODULE

Key Points: Apollo 9 Command Module (Original) - **Launched Mar 3, 1969.** Built by North American Rockwell, Downey, CA. Astronauts **James McDivitt (Cdr), David Scott (CM pilot), Russell Schweickart (LM pilot). 152 orbits in 10 days, 1 hour; 120 mile orbital altitude.**

This: The **original** Apollo 9 Command Module, on loan from the Smithsonian National Air & Space Museum.

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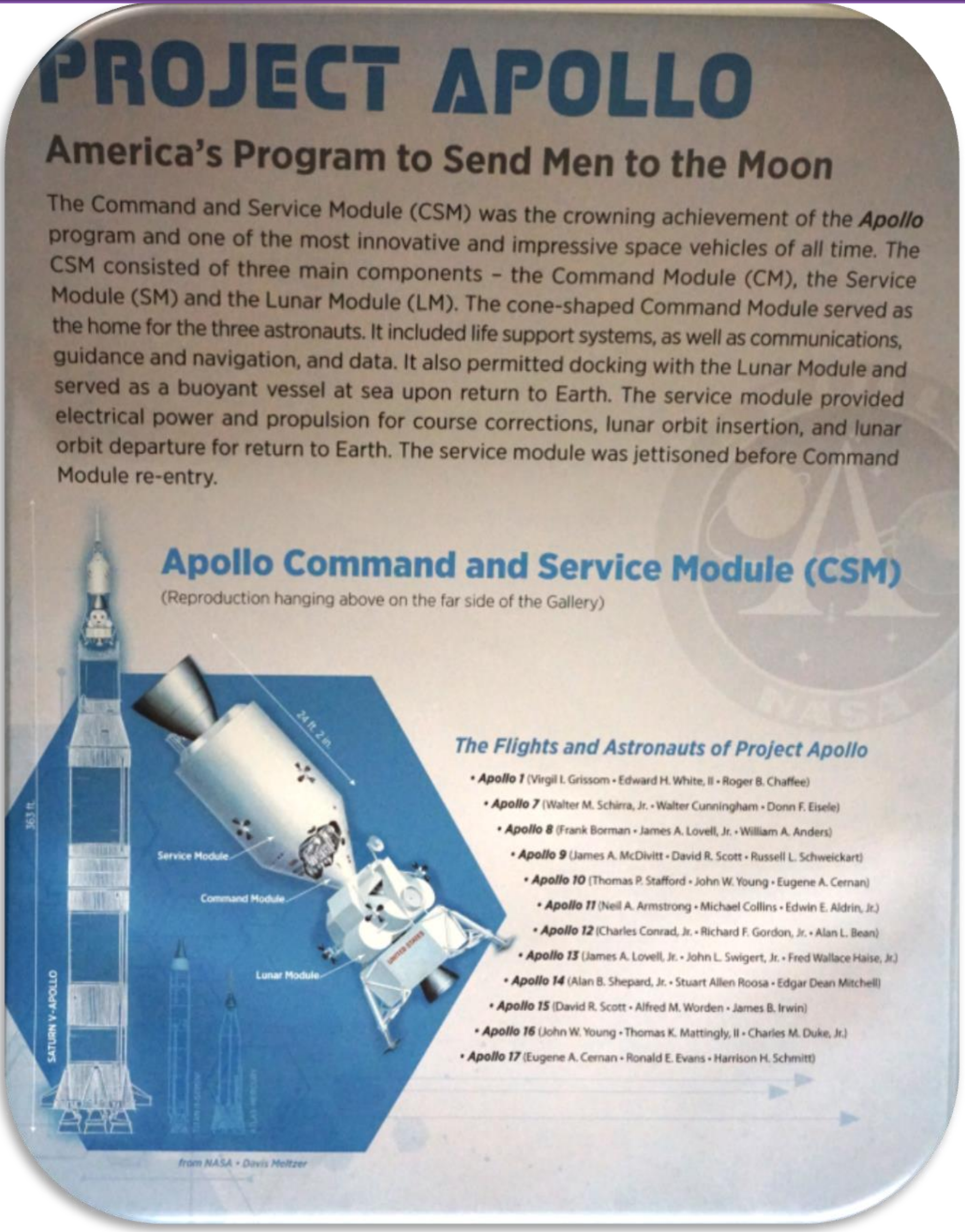

PROJECT APOLLO

America's Program to Send Men to the Moon

The Command and Service Module (CSM) was the crowning achievement of the *Apollo* program and one of the most innovative and impressive space vehicles of all time. The CSM consisted of three main components – the Command Module (CM), the Service Module (SM) and the Lunar Module (LM). The cone-shaped Command Module served as the home for the three astronauts. It included life support systems, as well as communications, guidance and navigation, and data. It also permitted docking with the Lunar Module and served as a buoyant vessel at sea upon return to Earth. The service module provided electrical power and propulsion for course corrections, lunar orbit insertion, and lunar orbit departure for return to Earth. The service module was jettisoned before Command Module re-entry.

Apollo Command and Service Module (CSM)

(Reproduction hanging above on the far side of the Gallery)

from NASA • Davis Meltzer

The Flights and Astronauts of Project Apollo

- **Apollo 1** (Virgil I. Grissom • Edward H. White, II • Roger B. Chaffee)
- **Apollo 7** (Walter M. Schirra, Jr. • Walter Cunningham • Donn F. Eisele)
- **Apollo 8** (Frank Borman • James A. Lovell, Jr. • William A. Anders)
- **Apollo 9** (James A. McDivitt • David R. Scott • Russell L. Schweickart)
- **Apollo 10** (Thomas P. Stafford • John W. Young • Eugene A. Cernan)
- **Apollo 11** (Neil A. Armstrong • Michael Collins • Edwin E. Aldrin, Jr.)
- **Apollo 12** (Charles Conrad, Jr. • Richard F. Gordon, Jr. • Alan L. Bean)
- **Apollo 13** (James A. Lovell, Jr. • John L. Swigert, Jr. • Fred Wallace Haise, Jr.)
- **Apollo 14** (Alan B. Shepard, Jr. • Stuart Allen Roosa • Edgar Dean Mitchell)
- **Apollo 15** (David R. Scott • Alfred M. Worden • James B. Irwin)
- **Apollo 16** (John W. Young • Thomas K. Mattingly, II • Charles M. Duke, Jr.)
- **Apollo 17** (Eugene A. Cernan • Ronald E. Evans • Harrison H. Schmitt)

1st Manned Flight: 1968

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Space Gallery

Extra Info:

>Apollo 9 launched Mar 3, 1969, with **Saturn 5**, 3-stage Rocket. Command Module called '**Gumdrop**', Lunar Module called '**Spider**'. Command Module **Landed Mar 13, 1969 – 180 miles East of Bahamas**. Re-entry speed was **24,640 MPH**.

>Apollo 9 spacecraft had two million working parts. **Heat Shield** - Brazed stainless steel honeycomb & phenolic epoxy (ablative), .7 to 2.7" thick. **CM Structure** - aluminum honeycomb, .5 to 1.5" thick. **12,405 lbs** launch weight.

>Apollo 9 First test flight of lunar lander in earth orbit. Undocked, tested both **LM engines** and re-docked. Separated over 100 miles. Test of **Portable Life Support System**; **two person EVA's**; **docking of manned spacecraft**; flight and testing of all lunar hardware.

>The Apollo Program sent **nine expeditions** to the moon. A total of 6 landings allowed **twelve astronauts to walk on the moon's surface**, and **twelve others circled the moon**.

Note: The original Apollo plan had Apollo 8 testing the Lunar Lander Module and its engines, self contained suits, docking, etc., in earth orbit and Apollo 9 leaving earth orbit, going into lunar orbit and returning to earth. Grumman was behind schedule with the Lunar Lander and could not meet the Apollo 8 launch date, but could meet the Apollo 9 launch date. NASA decided to switch the missions around. Apollo 8 went into lunar orbit, but **did not have a lunar module** on board. Apollo 9 tested the Lunar Module, space suits, etc., **in earth orbit**.

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Apollo Flights

**Schirra* & *Anders* are San Diego Astronauts

Apollo 1 Saturn IB Grissom White Chaffee 21 February 1967 (Planned)

Never launched. On 27 January 1967, a **fire erupted** in the Apollo command module during a test on the launch pad, destroying the module and killing astronauts Grissom, White, and Chaffee. The Saturn 1B launch vehicle, serial number AS-204, was undamaged and later used for the Apollo 5 mission.

Apollo 7 Saturn IB **Schirra*** Eisele Cunningham 11 October 1968 - 10d 20h

A test flight of the Block II CSM in Earth orbit, Apollo 7 was the **first manned Apollo flight** and the first manned flight of the Saturn IB. It was the only manned Apollo launch not from LC 39. It included the **first live TV** broadcast from an American spacecraft.

Apollo 8 Saturn V Borman Lovell **Anders*** 21 December 1968 - 06d 03h

Apollo 8 was the **first manned circumlunar** flight of the CSM (10 orbits in 20 hours) and the first manned flight of the Saturn V. The crew were the first humans to see the far side of the Moon and **earth rise** over the lunar horizon with their own eyes. Live television pictures were broadcast to Earth.

Apollo 9 Saturn V McDivitt Scott Schweickart Gumdrop Spider 3 March 1969 - 10d 01h

During 10 days in Earth orbit, Apollo 9 conducted the first manned flight test of the Lunar Module, demonstrating its propulsion and ability to rendezvous and dock with the CSM. An EVA tested the Portable Life Support System (PLSS).

Apollo 10 Saturn V Stafford Young Cernan Charlie Brown Snoopy 18 May 1969 - 08d 00h

In this "**dress rehearsal**" for the lunar landing, Apollo 10's Lunar Module was flown manned around the Moon and **descended to 8.4 nautical miles** (15.6 km) without landing.

Apollo 11 Saturn V Armstrong Collins Aldrin Columbia Eagle 16 July 1969 - 08d 03h

On July 20, 1969, the Apollo 11 Lunar Module performed the **first manned landing on the Moon** in the Sea of Tranquility, overcoming navigation errors and computer alarms. Astronauts Armstrong and Aldrin performed a single EVA in the direct vicinity of the LM.

Apollo 12 Saturn V Conrad Gordon Bean Yankee Clipper Intrepid 14 November 1969 - 10d 04h

Apollo 12 performed the first precise manned landing on the Moon in the Ocean of Storms near the Surveyor 3 probe. In two EVAs, the astronauts **recovered portions of Surveyor** and returned them to Earth. First controlled **LM ascent stage impact after jettison**; first use of deployable S-band antenna; **TV camera damaged** by accidental exposure to sun.

Apollo 13 Saturn V Lovell Swigert Haise Odyssey Aquarius 11 April 1970 - 05d 22h

Intended to land at Fra Mauro, Apollo 13's mission was aborted after an **SM oxygen tank exploded** on the trip to the moon, causing the landing to be cancelled. After a single loop around the moon, the **LM was used as crew "lifeboat"** for safe return. First S-IVB stage impact on Moon as active seismic test.

Apollo 14 Saturn V Shepard Roosa Mitchell Kitty Hawk Antares 31 January 1971 - 09d 00h

After docking problems, a faulty LM abort switch and delayed landing radar acquisition, Apollo 14's LM landed successfully at Fra Mauro. **First color video** images from the surface of the Moon, first materials **science experiments** in space, and two EVAs, in one of which Shepard performed **a golf shot**.

Apollo 15 Saturn V Scott Worden Irwin Endeavour Falcon 26 July 1971 12d 07h

Apollo 15, landing at Hadley–Apennine was the first "J series" mission with a 3-day lunar stay and extensive geology investigations. **First use of the Lunar Roving Vehicle, driving 17.25 miles**; 1 lunar "standup" EVA, 3 lunar surface EVAs and deep space EVA on return to retrieve orbital camera film from SM.

Apollo 16 Saturn V Young Mattingly Duke Casper Orion 16 April 1972 11d 01h

After a malfunction in a backup CSM yaw gimbal servo loop delayed the landing and reduced CSM time in lunar orbit, Apollo 16's LM landed in the Descartes Highlands. No ascent stage deorbit due to malfunction; 3 lunar EVAs and deep space EVA.

Apollo 17 Saturn V Cernan Evans Schmitt America Challenger 7 December 1972 - 12d 13h

The final Apollo lunar mission landed at Taurus–Littrow. Schmitt, a geologist, was the **first professional scientist** to go on a NASA mission. First night launch; 3 lunar EVAs and deep space EVA. As of 2015, the last manned spaceflight beyond low Earth orbit.

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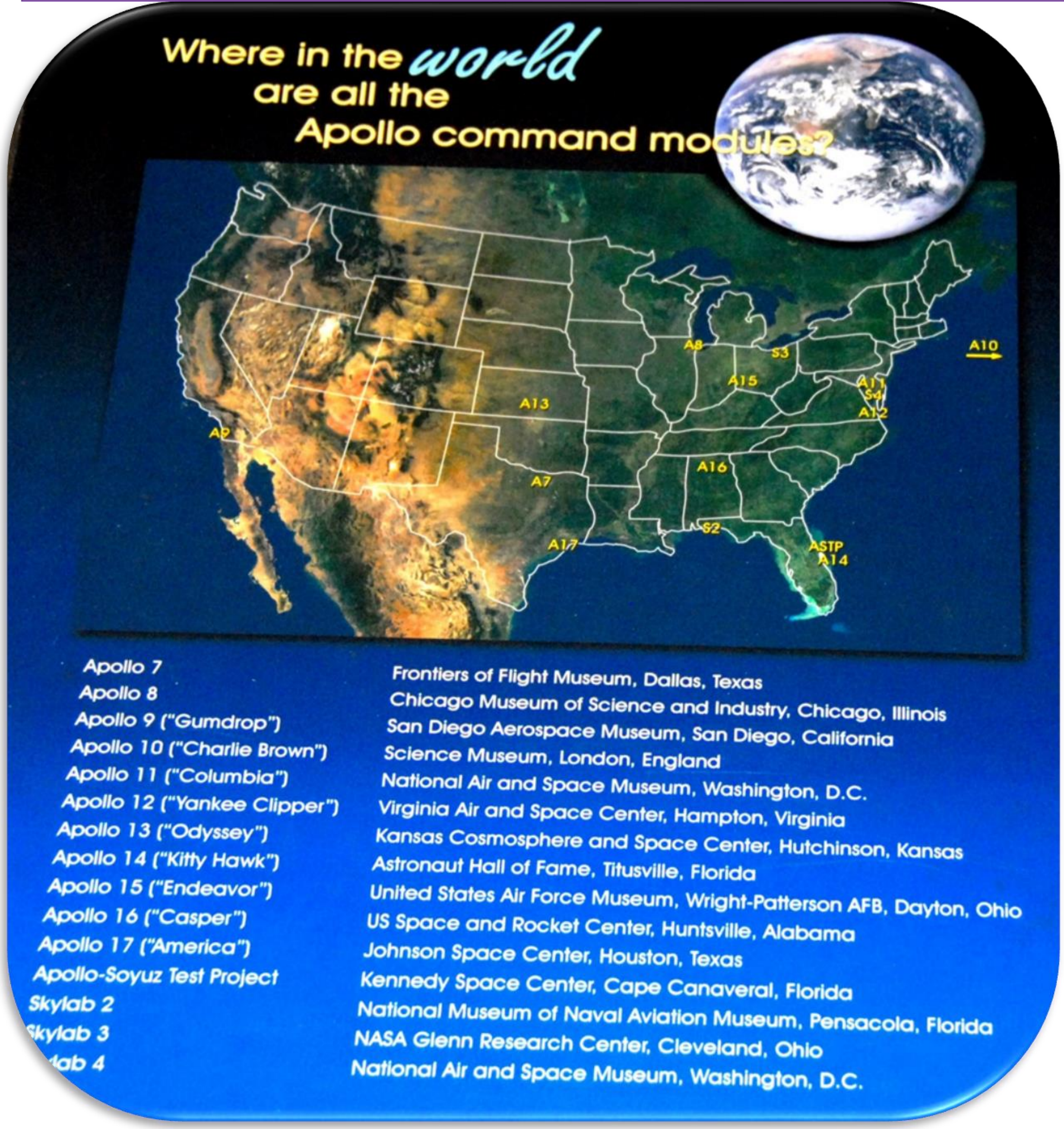
Space Gallery



Where in the world are all the Apollo command modules?

Apollo 7	Frontiers of Flight Museum, Dallas, Texas
Apollo 8	Chicago Museum of Science and Industry, Chicago, Illinois
Apollo 9 ("Gumdrop")	San Diego Aerospace Museum, San Diego, California
Apollo 10 ("Charlie Brown")	Science Museum, London, England
Apollo 11 ("Columbia")	National Air and Space Museum, Washington, D.C.
Apollo 12 ("Yankee Clipper")	Virginia Air and Space Center, Hampton, Virginia
Apollo 13 ("Odyssey")	Kansas Cosmosphere and Space Center, Hutchinson, Kansas
Apollo 14 ("Kitty Hawk")	Astronaut Hall of Fame, Titusville, Florida
Apollo 15 ("Endeavor")	United States Air Force Museum, Wright-Patterson AFB, Dayton, Ohio
Apollo 16 ("Casper")	US Space and Rocket Center, Huntsville, Alabama
Apollo 17 ("America")	Johnson Space Center, Houston, Texas
Apollo-Soyuz Test Project	Kennedy Space Center, Cape Canaveral, Florida
Skylab 2	National Museum of Naval Aviation Museum, Pensacola, Florida
kylab 3	NASA Glenn Research Center, Cleveland, Ohio
lab 4	National Air and Space Museum, Washington, D.C.

Command Module Locations:

7 – Dallas, TX

8 – Chicago, IL

9 – San Diego, CA

10 – London, England

11 – Smithsonian, Washington, DC

12 – Hampton, VA

13 – Hutchinson, KA

14 – Tutusville, FL

15 – Dayton, OH (Wright-Patterson)

16 – Huntsville, AL

17 – Houston, TX

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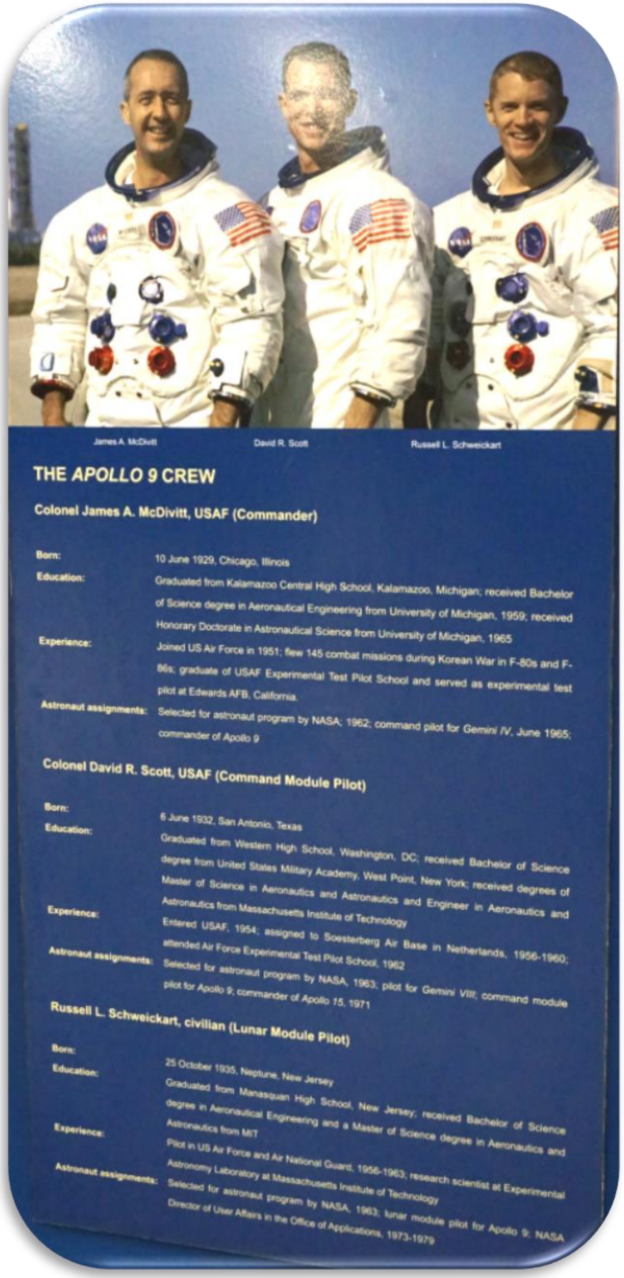

James A. McDivitt David R. Scott Russell L. Schweickart

THE *APOLLO 9* CREW

Colonel James A. McDivitt, USAF (Commander)

Born: 10 June 1929, Chicago, Illinois

Education: Graduated from Kalamazoo Central High School, Kalamazoo, Michigan; received Bachelor of Science degree in Aeronautical Engineering from University of Michigan, 1959; received Honorary Doctorate in Astronautical Science from University of Michigan, 1965

Experience: Joined US Air Force in 1951; flew 145 combat missions during Korean War in F-80s and F-86s; graduate of USAF Experimental Test Pilot School and served as experimental test pilot at Edwards AFB, California.

Astronaut assignments: Selected for astronaut program by NASA; 1962; command pilot for *Gemini IV*, June 1965; commander of *Apollo 9*

Colonel David R. Scott, USAF (Command Module Pilot)

Born: 6 June 1932, San Antonio, Texas

Education: Graduated from Western High School, Washington, DC; received Bachelor of Science degree from United States Military Academy, West Point, New York; received degrees of Master of Science in Aeronautics and Astronautics and Engineer in Aeronautics and Astronautics from Massachusetts Institute of Technology

Experience: Entered USAF, 1954; assigned to Soesterberg Air Base in Netherlands, 1956-1960; attended Air Force Experimental Test Pilot School, 1962

Astronaut assignments: Selected for astronaut program by NASA, 1963; pilot for *Gemini VIII*; command module pilot for *Apollo 9*; commander of *Apollo 15*, 1971

Russell L. Schweickart, civilian (Lunar Module Pilot)

Born: 25 October 1935, Neptune, New Jersey

Education: Graduated from Manasquan High School, New Jersey; received Bachelor of Science degree in Aeronautical Engineering and a Master of Science degree in Aeronautics and Astronautics from MIT

Experience: Pilot in US Air Force and Air National Guard, 1956-1963; research scientist at Experimental Astronomy Laboratory at Massachusetts Institute of Technology

Astronaut assignments: Selected for astronaut program by NASA, 1963; lunar module pilot for Apollo 9; NASA Director of User Affairs in the Office of Applications, 1973-1979

Key Points: **The Apollo 9 Crew**.

Col James A. McDivitt, USAF (**Commander**)
Born: 10 Jun 1929, Chicago, Illinois.
BS Aero Engineering, Univ of Michigan.
Hon Doctorate, Aero Science, Univ. Michigan.
145 Combat missions Korea (F-80 & F-86).
Command Pilot - Gemini IV; Commander - Apollo 9.

Col David R. Scott, USAF (**Command Module Pilot**)
Born: 6 Jun 1932, San Antonio, Texas.
BS, USMA West Point.
MS Aero/Astronautics, MIT.
Engineer in Aero/Astronautics, MIT.
Pilot – **Gemini VIII**; Command Module Pilot - **Apollo 9**; Commander - **Apollo 15**.

Russell L. Schweickart, Civilian (**Lunar Module Pilot**)
Born: 25 Oct 1935, Neptune, New Jersey.
BS, Aero Engineering, MIT
MS, Aero/Astronautics, MIT.
Lunar Module Pilot – **Apollo 9**

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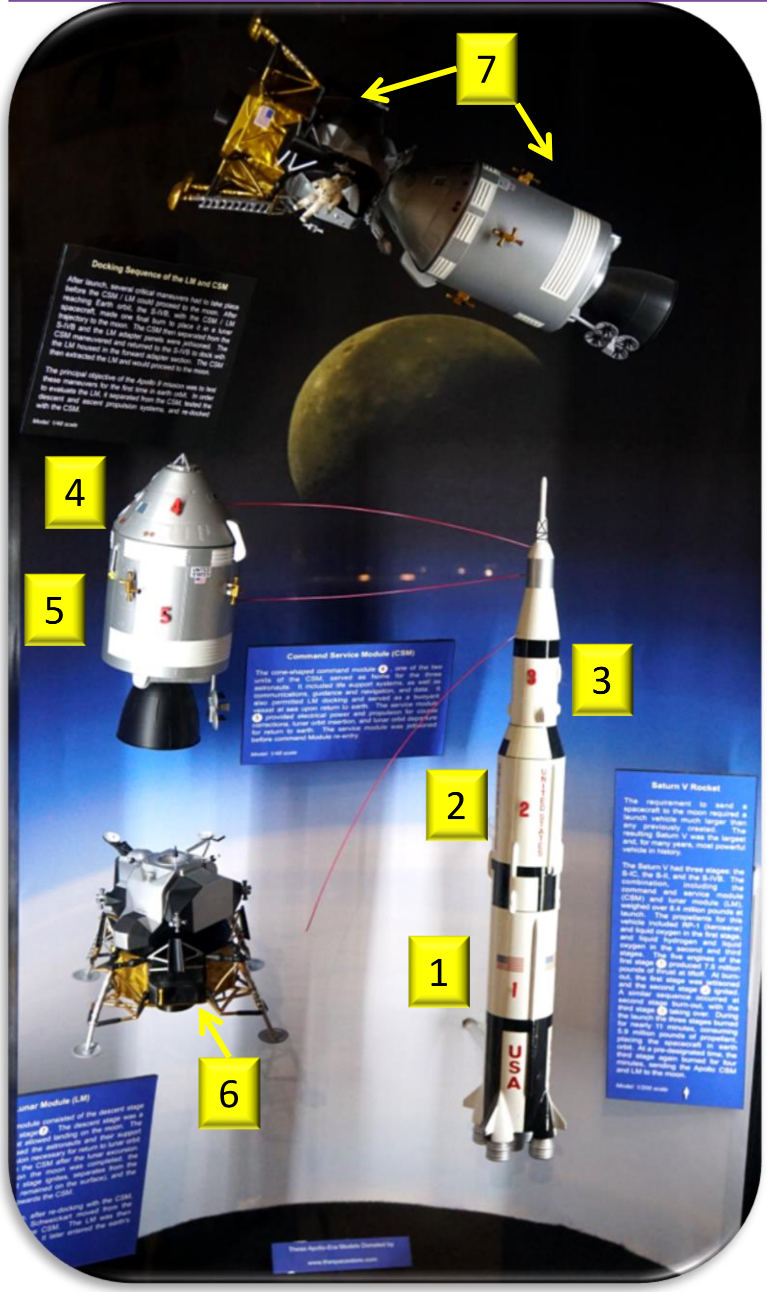
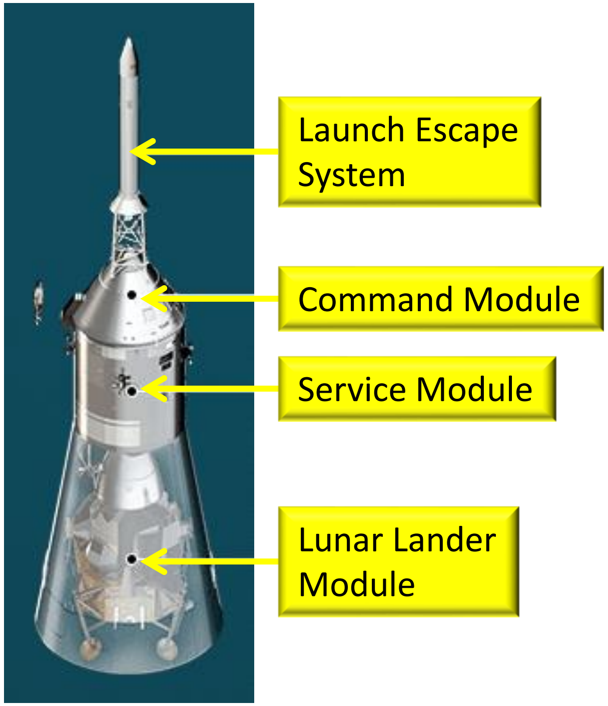
Space Gallery


7
Docking Sequence of the LM and CSM
4
5
Command Service Module (CSM)
3
Saturn V Rocket
2
1
Lunar Module (LM)
6

Key Points: Apollo Diorama

1 – Saturn V Rocket **first stage**.
2 – Saturn V Rocket **second stage**.
3 – Saturn V Rocket **third stage**.
4 – Apollo **Command Module (CM)**.
5 – Apollo **Service Module (SM)**.
6 – Apollo **Lunar Module (LM)**.
7 – CM & SM docked with the LM.

Diorama shows how the Command, Service and Lunar Modules were configured for launch, enroute to the Moon and landing.


Launch Escape System
Command Module
Service Module
Lunar Lander Module

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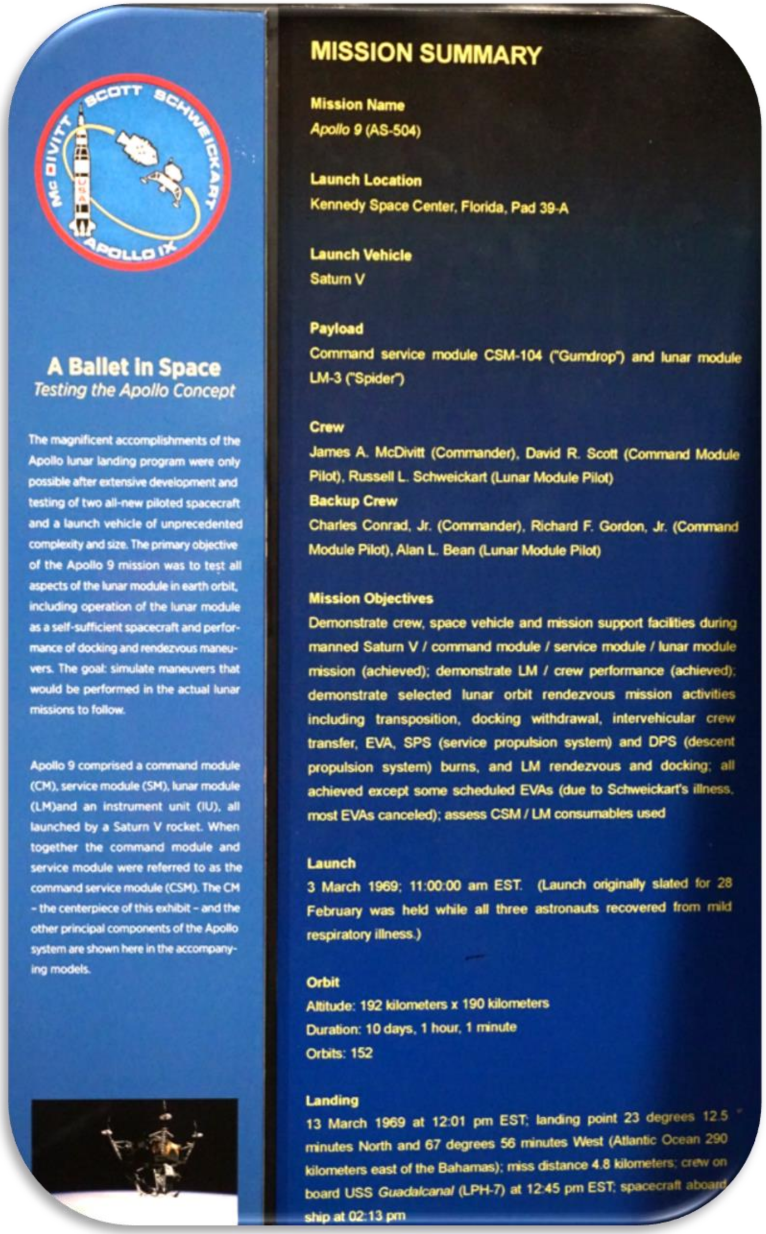

A Ballet in Space

Testing the Apollo Concept

The magnificent accomplishments of the Apollo lunar landing program were only possible after extensive development and testing of two all-new piloted spacecraft and a launch vehicle of unprecedented complexity and size. The primary objective of the Apollo 9 mission was to test all aspects of the lunar module in earth orbit, including operation of the lunar module as a self-sufficient spacecraft and performance of docking and rendezvous maneuvers. The goal: simulate maneuvers that would be performed in the actual lunar missions to follow.

Apollo 9 comprised a command module (CM), service module (SM), lunar module (LM)and an instrument unit (IU), all launched by a Saturn V rocket. When together the command module and service module were referred to as the command service module (CSM). The CM – the centerpiece of this exhibit – and the other principal components of the Apollo system are shown here in the accompanying models.

MISSION SUMMARY

Mission Name

Apollo 9 (AS-504)

Launch Location

Kennedy Space Center, Florida, Pad 39-A

Launch Vehicle

Saturn V

Payload

Command service module CSM-104 ("Gumdrop") and lunar module LM-3 ("Spider")

Crew

James A. McDivitt (Commander), David R. Scott (Command Module Pilot), Russell L. Schweickart (Lunar Module Pilot)

Backup Crew

Charles Conrad, Jr. (Commander), Richard F. Gordon, Jr. (Command Module Pilot), Alan L. Bean (Lunar Module Pilot)

Mission Objectives

Demonstrate crew, space vehicle and mission support facilities during manned Saturn V / command module / service module / lunar module mission (achieved); demonstrate LM / crew performance (achieved); demonstrate selected lunar orbit rendezvous mission activities including transposition, docking withdrawal, intervehicular crew transfer, EVA, SPS (service propulsion system) and DPS (descent propulsion system) burns, and LM rendezvous and docking; all achieved except some scheduled EVAs (due to Schweickart's illness, most EVAs canceled); assess CSM / LM consumables used

Launch

3 March 1969; 11:00:00 am EST. (Launch originally slated for 28 February was held while all three astronauts recovered from mild respiratory illness.)

Orbit

Altitude: 192 kilometers x 190 kilometers

Duration: 10 days, 1 hour, 1 minute

Orbits: 152

Landing

13 March 1969 at 12:01 pm EST; landing point 23 degrees 12.5 minutes North and 67 degrees 56 minutes West (Atlantic Ocean 290 kilometers east of the Bahamas); miss distance 4.8 kilometers; crew on board USS *Guadalcanal* (LPH-7) at 12:45 pm EST; spacecraft aboard ship at 02:13 pm

Key Points: **Mission Summary:**

- **Name: Apollo 9.**
- **Launch: March 3, 1969**, 11:00 AM, from Kennedy Space Center, Florida, Pad 39-A.
- Launch Vehicle: Saturn V.
- **Crew: McDivitt, Scott, Schweickart.**
- **Mission: Test all Apollo equipment and procedures necessary for a landing on the Moon including flight testing of the Lunar Module.**
- **Orbit: 118 miles.**
- **Duration: 10 days, 1 hour, 1 minute.**
- **Orbits: 152.**
- **Landing: Mar 13, 1969, 180 miles East of the Bahamas.** Accuracy of landing – 3 miles from center. Crew picked up by USS Guadalcanal.

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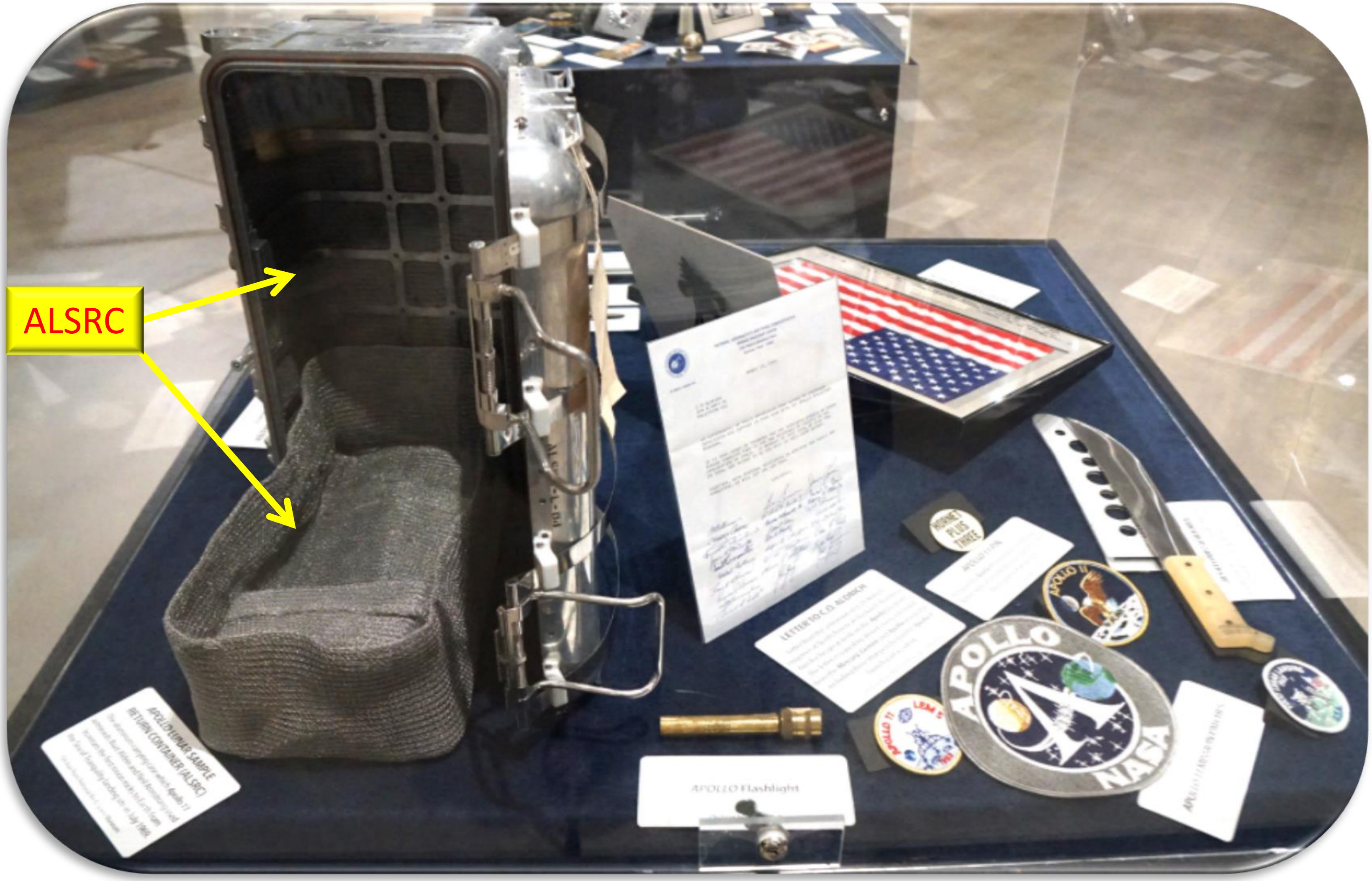
ALSRC
APOLLO LUNAR SAMPLE RETURN CONTAINER (ALSRC)
LETTER TO C.D. ALDRICH
HORNET PLUS THREE
APOLLO 11
APOLLO
NASA
APOLLO Flashlight

Key Points: Apollo 11 and 12 memorabilia (**Originals**). Apollo Lunar Sample Return Container (ALSRC), Buzz Aldren photo, signed US Flag "To The People of San Diego", Apollo 11 Mission patches, etc.

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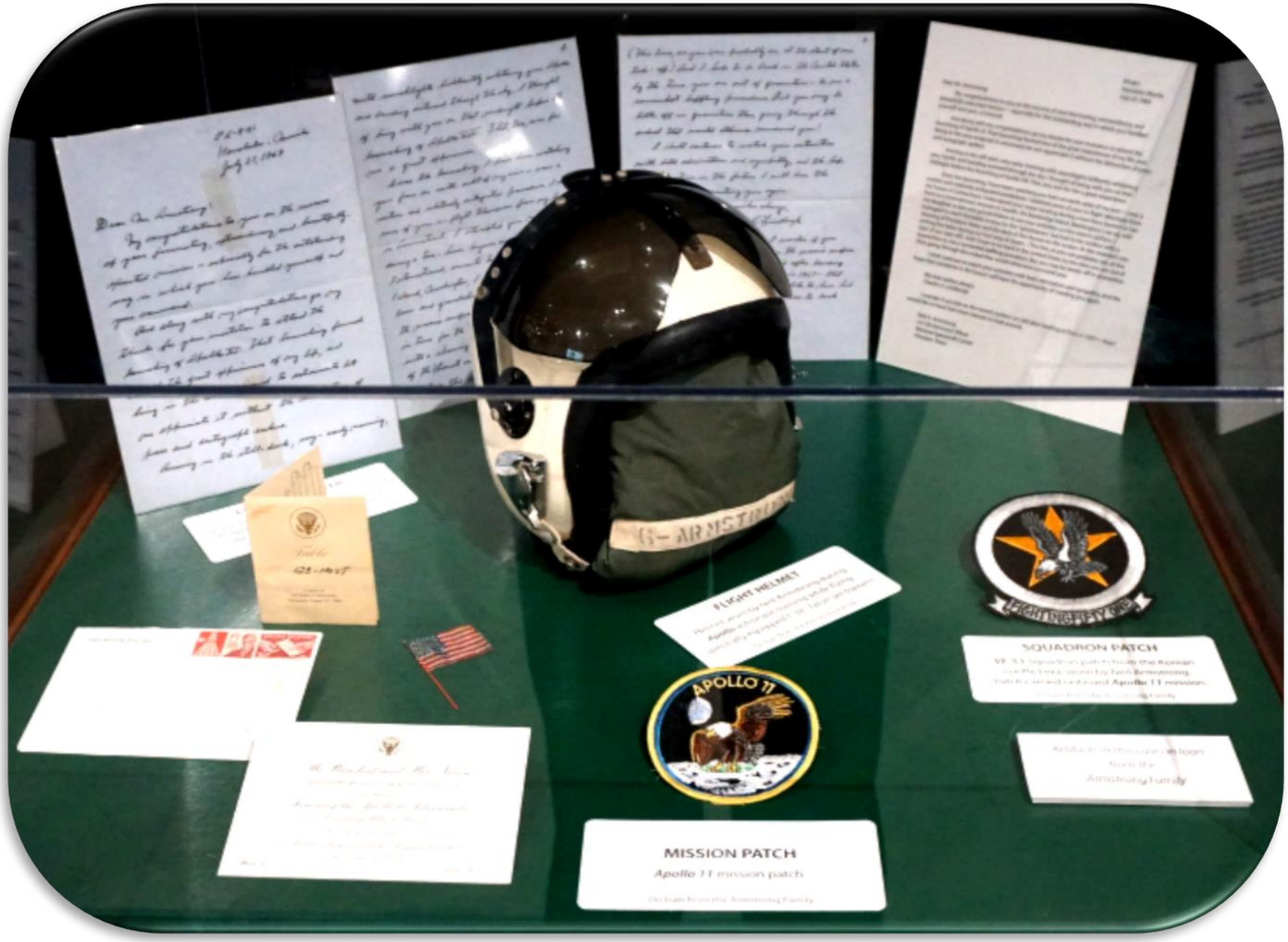
G-ARMSTRONG
FLIGHT HELMET
FIGHTING FIFTY ONE
SQUADRON PATCH
APOLLO 11
MISSION PATCH
Apollo 11 mission patch

Key Points: **Neil Armstrong Memorabilia** (**Originals**). **Armstrong's** astronaut training helmet, Apollo 11 patch, VF-51 Squadron patch from his Korean service, congratulatory letter from Charles Lindberg.

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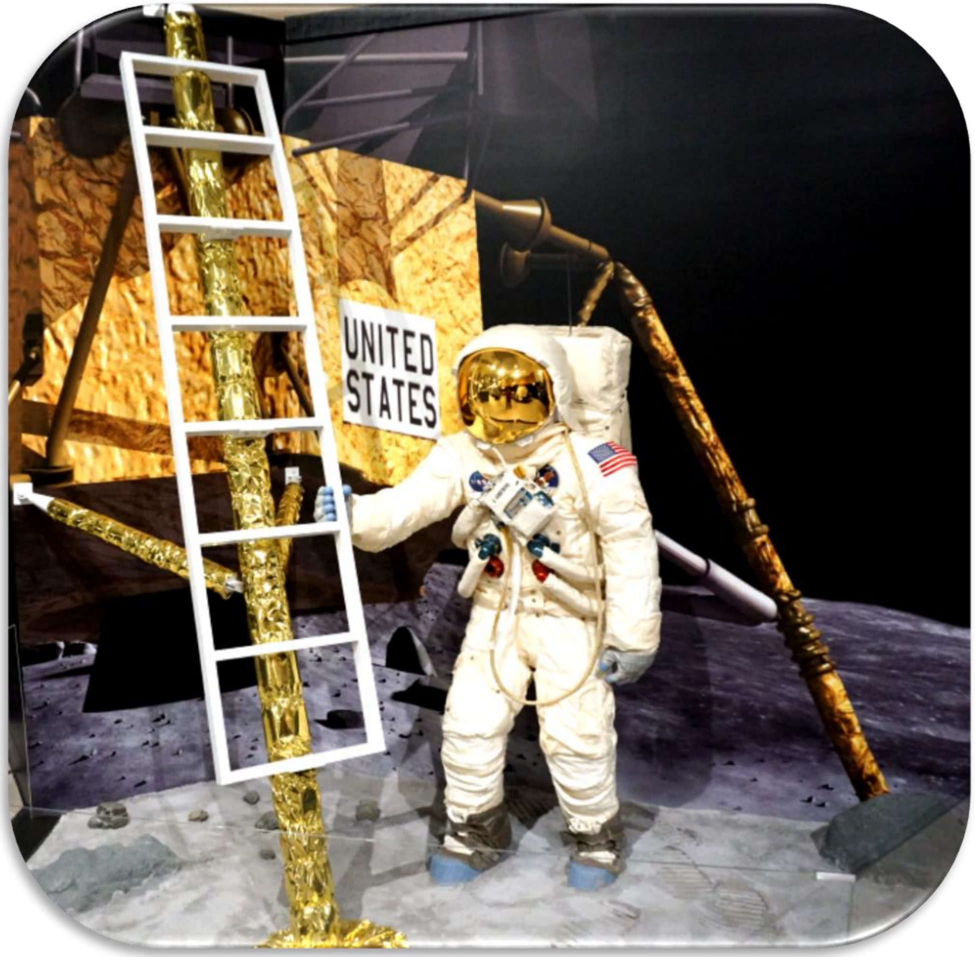

Key Points: Apollo 11 Lunar Module on the Moon (Full Sized Model)**. July 20, 1969**, diorama of Apollo 11 Lunar Module ***Eagle*** sitting on the moon at ***Tranquility Base.*** Astronaut **Neil Armstrong** is standing by the egress ladder as he says **"That's one small step for (a) man, one giant leap for mankind."**

Armstrong and **Buzz Aldrin** spent about **2 ¼ hours outside the spacecraft on the lunar surface**.

Note: Armstrong and Aldrin collected **47.5 pounds** of lunar material to bring back to Earth. They spent **21 hours, 36 minutes** on the lunar surface. **Michael Collins** flew the Command Module ***Columbia*** alone in lunar orbit while they were on the Moon's surface. Total mission duration: **8 days, 3 hours, 18 minutes**.

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Space Gallery

Note: On landing, Eagle overshot its intended point by 4 miles. At 400 feet altitude they were headed for a crater and boulders. Armstrong manually flew 500 meters to smoother ground. They landed with 15 to 25 seconds of fuel remaining.
The astronauts stepped onto the moon about 4.5 hours after touching down.
They collected samples, took pictures and video, planted an American flag and a plaque, set up a couple of experiments, and took a call from the White House.
After the Apollo 11 astronauts were safely back on Earth, NASA quarantined them for 21 days in case they had brought back moon germs.

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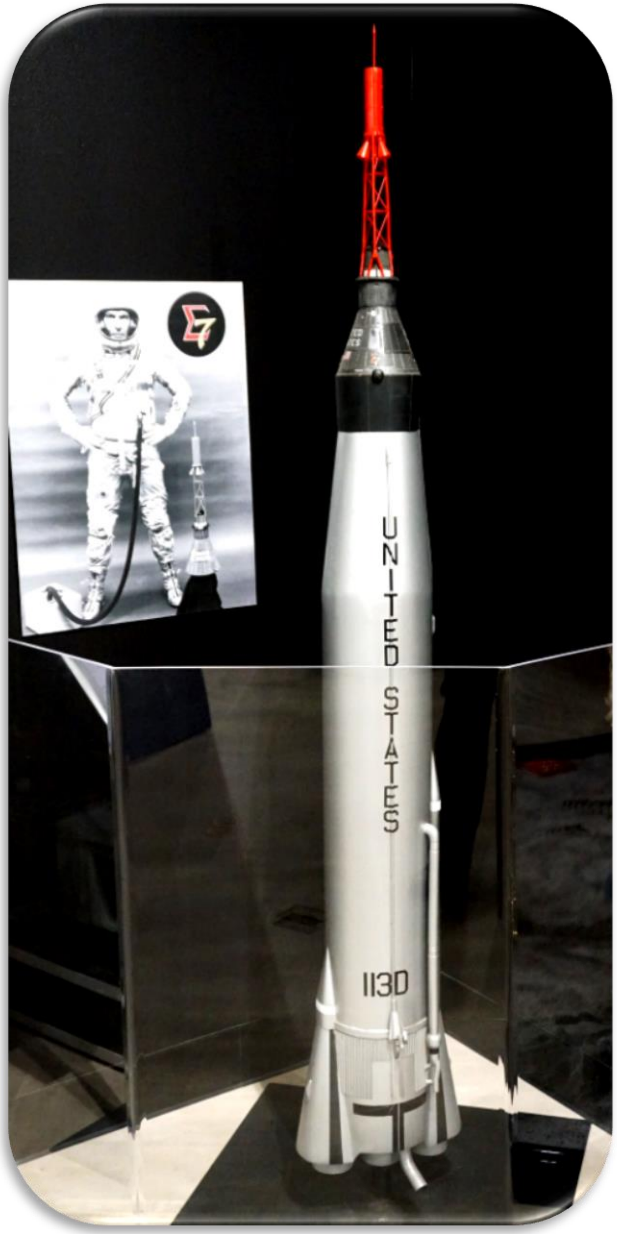

1st Flight:
1960

Key Points: **Atlas D Booster** (Model) - Atlas D series of rockets were used to **launch all Mercury orbital missions**. Built by San Diego's Convair Company the Atlas was originally designed as an ICBM. The Atlas was the only rocket available with the thrust rating capable of boosting Mercury capsules high and fast enough to obtain earth orbit.

This: 1/15 scale model of Wally Schirra's "*Sigma 7*", built by the SDASM Model Shop at the Gillespie Field Annex.

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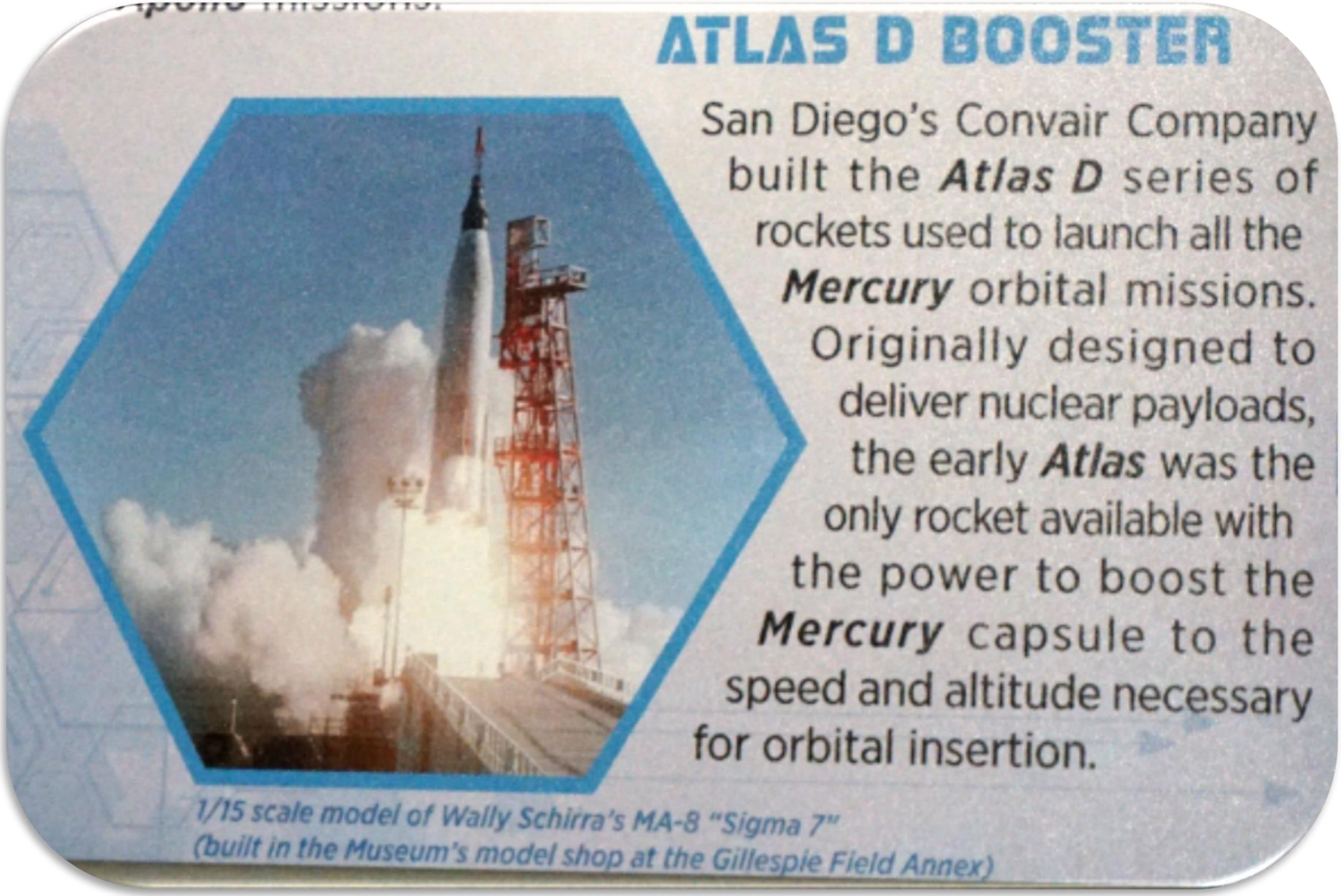

pollo missions.

ATLAS D BOOSTER

San Diego's Convair Company built the ***Atlas D*** series of rockets used to launch all the ***Mercury*** orbital missions. Originally designed to deliver nuclear payloads, the early ***Atlas*** was the only rocket available with the power to boost the ***Mercury*** capsule to the speed and altitude necessary for orbital insertion.

1/15 scale model of Wally Schirra's MA-8 "Sigma 7"
(built in the Museum's model shop at the Gillespie Field Annex)

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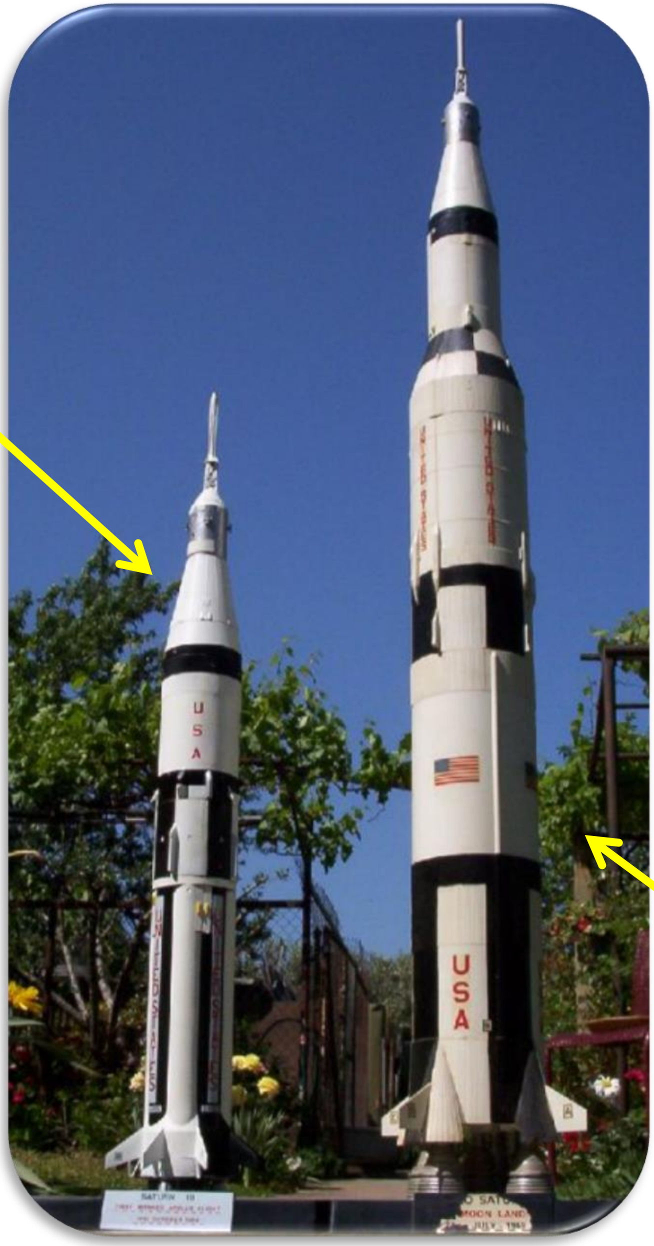
1st Flight:
1966

Saturn 1B



Key Points: **Saturn 1B** (Model) - Launch vehicle for **Apollo 7**. **Precursor** to **Saturn V**, which was used for all subsequent Apollo missions. First flight Feb 26, 1966, last flight Jul 15, 1975.

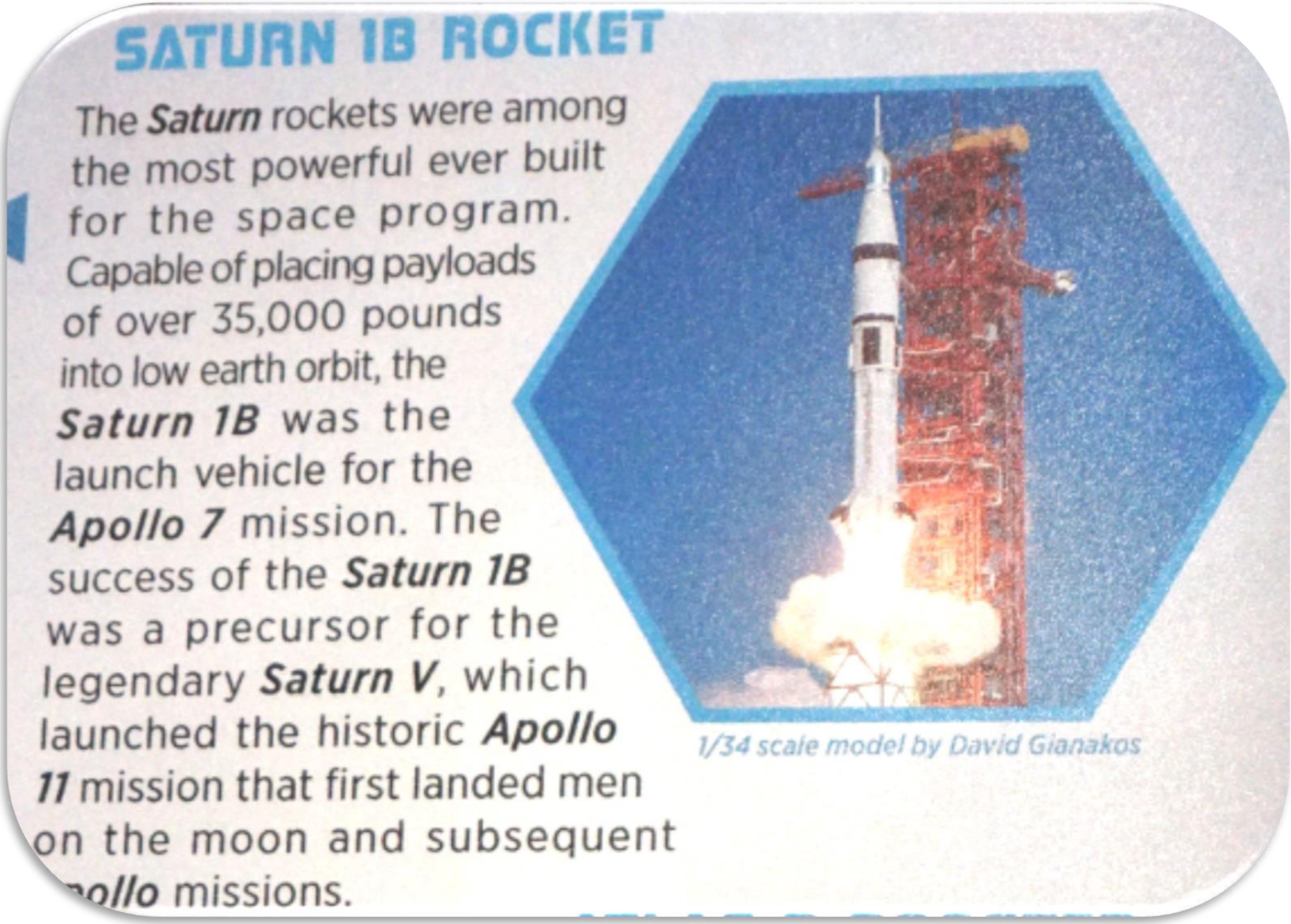
Saturn 1B was **224** feet tall; Saturn V was **363** feet tall.

Saturn V

1st Flight:
1967

Perspective: Each of the Saturn V's five F-1 engines were about as large as the Apollo Service Module hanging in the Space Gallery (overhead).

Space Gallery



SATURN 1B ROCKET

The ***Saturn*** rockets were among the most powerful ever built for the space program. Capable of placing payloads of over 35,000 pounds into low earth orbit, the ***Saturn 1B*** was the launch vehicle for the ***Apollo 7*** mission. The success of the ***Saturn 1B*** was a precursor for the legendary ***Saturn V***, which launched the historic ***Apollo 11*** mission that first landed men on the moon and subsequent *pollo* missions.

1/34 scale model by David Gianakos

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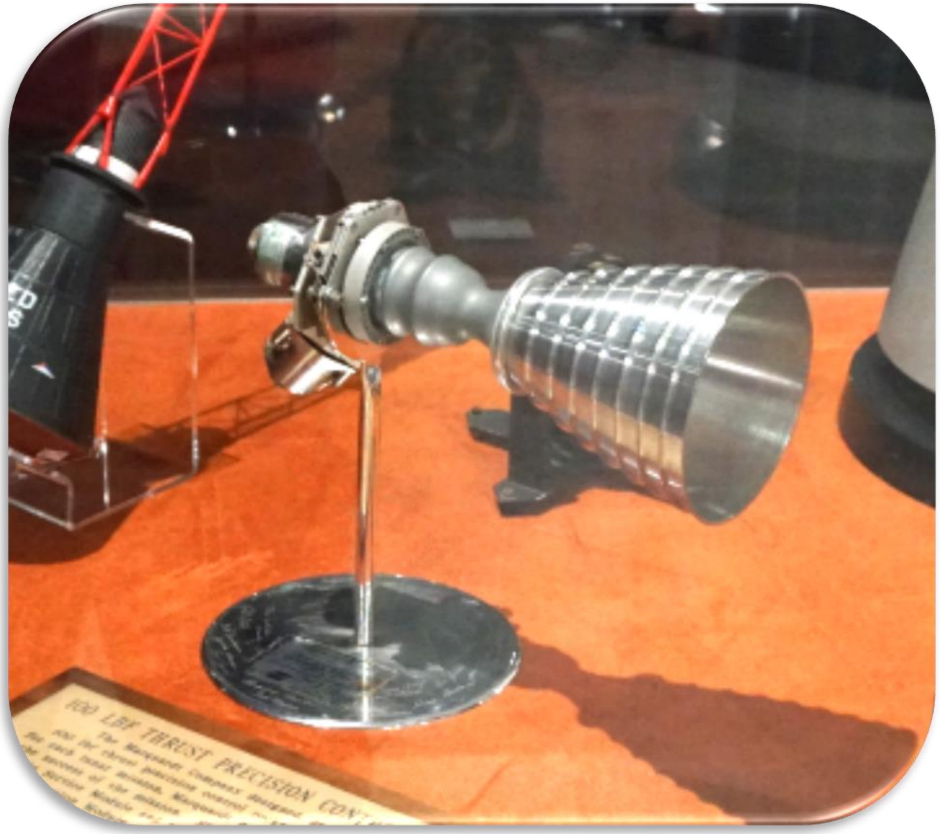
Space Gallery



1st Run:
1962

Key Points:

Precision Control Rocket Engine (Original Spare). Built by the Marquardt Company. 32 installed on each Apollo mission; 16 on Service Module, 16 on Lunar Module. Used like airplane ailerons, rudders and elevators to maneuver space craft in space. Used **Aerozine-50** fuel and **N_2O_4 (Nitrogen Tetroxide)** oxidizer (called **hypergolic Propellants,** they **ignite upon contact with each other**) to produce 100 pounds of thrust to allow **orbital and attitude adjustment, stabilization, maneuvers and docking**.

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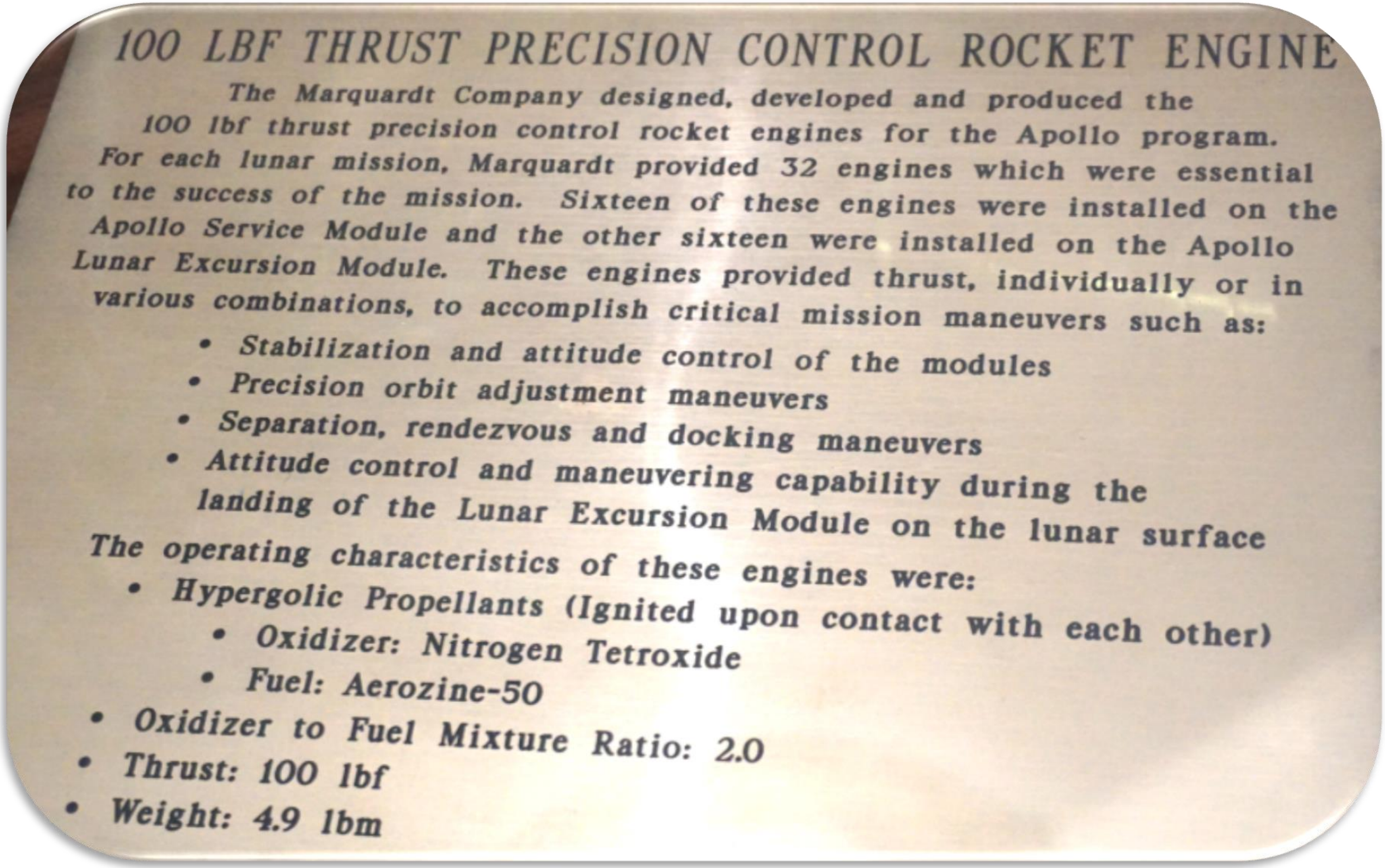
Space Gallery



100 LBF THRUST PRECISION CONTROL ROCKET ENGINE

The Marquardt Company designed, developed and produced the 100 lbf thrust precision control rocket engines for the Apollo program. For each lunar mission, Marquardt provided 32 engines which were essential to the success of the mission. Sixteen of these engines were installed on the Apollo Service Module and the other sixteen were installed on the Apollo Lunar Excursion Module. These engines provided thrust, individually or in various combinations, to accomplish critical mission maneuvers such as:

- Stabilization and attitude control of the modules
- Precision orbit adjustment maneuvers
- Separation, rendezvous and docking maneuvers
- Attitude control and maneuvering capability during the landing of the Lunar Excursion Module on the lunar surface

The operating characteristics of these engines were:

- Hypergolic Propellants (Ignited upon contact with each other)
  - Oxidizer: Nitrogen Tetroxide
  - Fuel: Aerozine-50
- Oxidizer to Fuel Mixture Ratio: 2.0
- Thrust: 100 lbf
- Weight: 4.9 lbm

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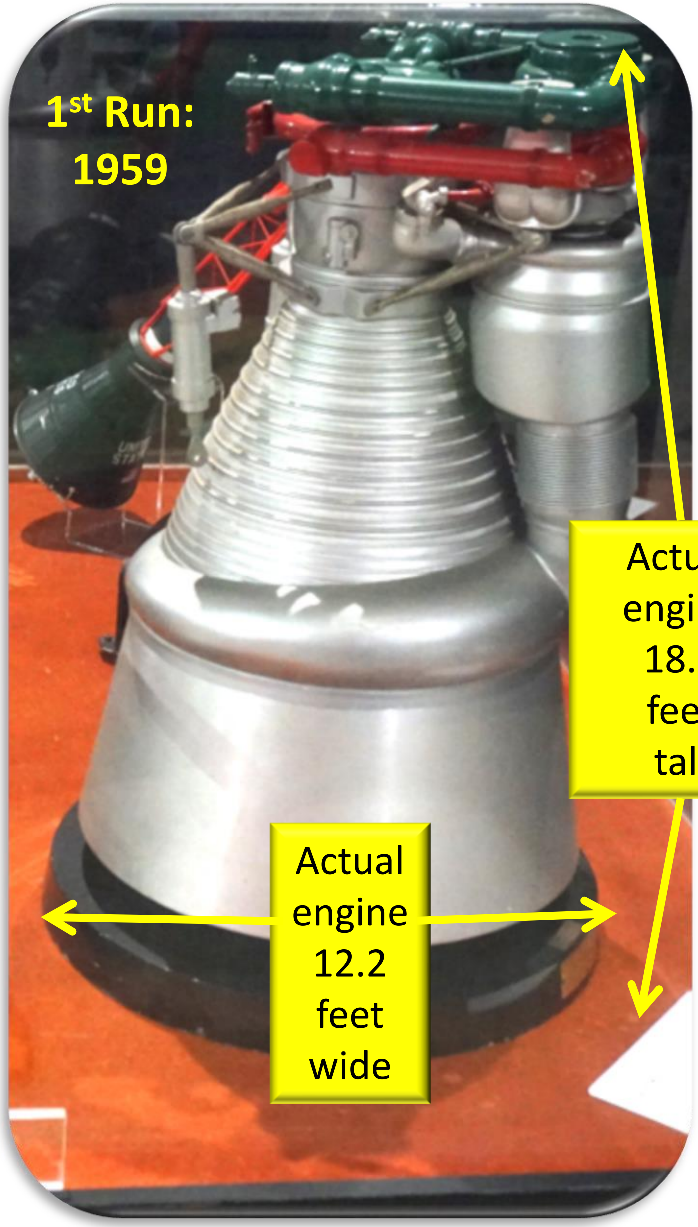
Space Gallery



Key Points: **Rocketdyne *Saturn V*, F-1 Rocket Engine** (**Model** 1:10 scale), **actual engine is 18.5 feet tall and 12.2 feet wide at the base** - The **F-1** is a gas generator-cycle rocket engine developed in the United States by Rocketdyne in the late 1950s. Used only in the ***Saturn V* rocket** in the 1960s and early 1970s. **Five F-1 engines** were used in the first stage of each ***Saturn V***, which served as the main launch vehicle of the Apollo program. Each engine developed 1.5 million pounds of thrust (and burned 671 gallons of fuel per second) for a total of 7.5 million pounds of thrust for the *Saturn V* rocket.

Perspective: Each of the *Saturn V's* five F-1 engines were about as large as the Apollo Service Module hanging in the Space Gallery (overhead).

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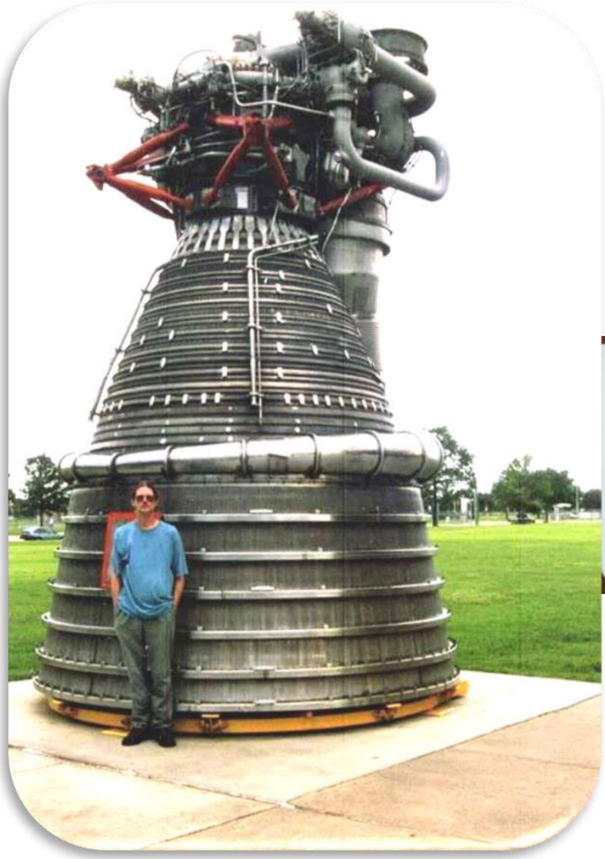
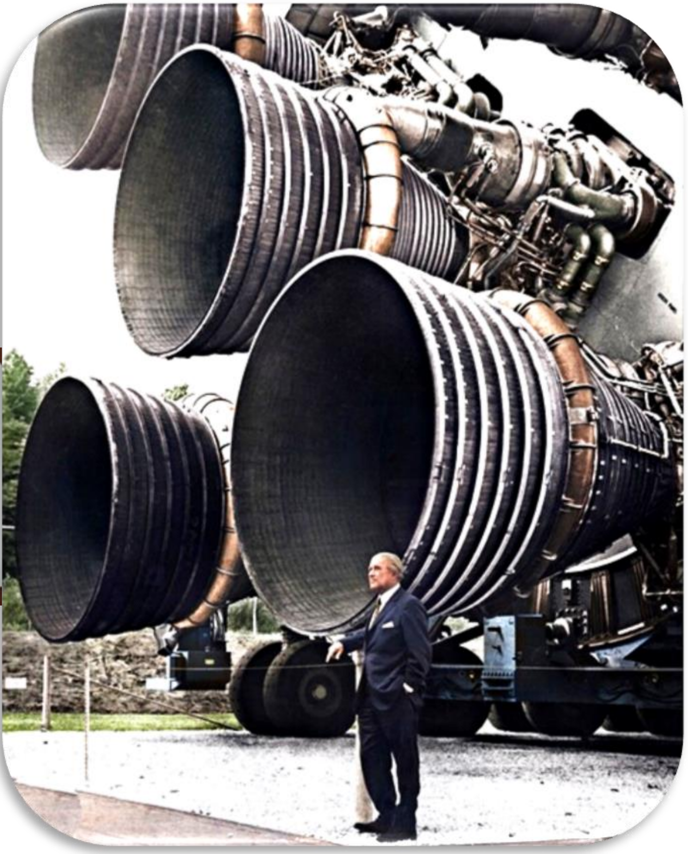
Space Gallery



ROCKETDYNE SATURN V F-1

Rocket engine.



The Rocketdyne *Saturn V*, F-1 engines remain the **most powerful single combustion chamber liquid-propellant rocket engines** ever developed.

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Space Gallery

USA
NASA
Challenger

Key Points: **Challenger – Columbia Space Shuttle Memorial Exhibit.** (Model) Space Shuttles were designed as a system of reusable spacecraft to launch satellites, probes, Hubble Space Telescope and participate in construction of the International Space Station. **Five complete Space Shuttles were built** and flew **135 missions from 1981 to 2011** (30 years); **two were lost**.

Challenger – Exploded 73 seconds after launch, **Jan 28, 1986**. **All 7 crew lost.**

Columbia – Disintegrated during re-entry over Texas, **Feb 1, 2003. All 7 crew lost.**

This exhibit dedicated to the brave men & women who dared to live their dreams greatly in the exploration of space.

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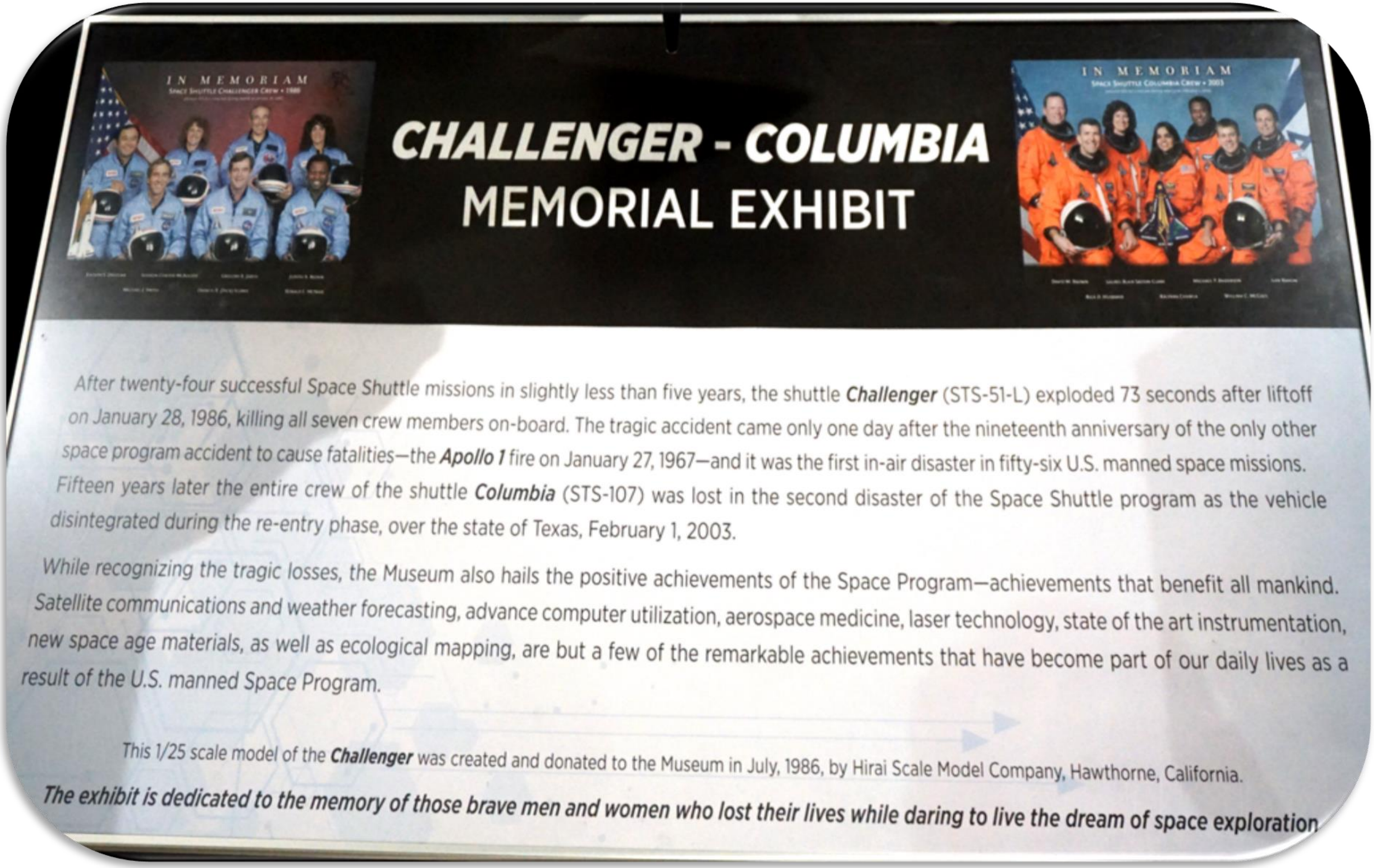
Space Gallery


IN MEMORIAM
Space Shuttle Challenger Crew • 1986
IN MEMORIAM
Space Shuttle Columbia Crew • 2003

CHALLENGER - COLUMBIA MEMORIAL EXHIBIT

After twenty-four successful Space Shuttle missions in slightly less than five years, the shuttle **Challenger** (STS-51-L) exploded 73 seconds after liftoff on January 28, 1986, killing all seven crew members on-board. The tragic accident came only one day after the nineteenth anniversary of the only other space program accident to cause fatalities—the ***Apollo 1*** fire on January 27, 1967—and it was the first in-air disaster in fifty-six U.S. manned space missions. Fifteen years later the entire crew of the shuttle ***Columbia*** (STS-107) was lost in the second disaster of the Space Shuttle program as the vehicle disintegrated during the re-entry phase, over the state of Texas, February 1, 2003.

While recognizing the tragic losses, the Museum also hails the positive achievements of the Space Program—achievements that benefit all mankind. Satellite communications and weather forecasting, advance computer utilization, aerospace medicine, laser technology, state of the art instrumentation, new space age materials, as well as ecological mapping, are but a few of the remarkable achievements that have become part of our daily lives as a result of the U.S. manned Space Program.

This 1/25 scale model of the ***Challenger*** was created and donated to the Museum in July, 1986, by Hirai Scale Model Company, Hawthorne, California.

The exhibit is dedicated to the memory of those brave men and women who lost their lives while daring to live the dream of space exploration

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Space Gallery

STS-110
MICHELIN AIR

Key Points: **Space Shuttle Tire –** One of 4 main landing gear tires from Space Shuttle **Atlantis** (Mission STS-110). It spent **10 days, 19+ hours in space**. Rated for speeds up to **263 mph**. Filled with nitrogen for altitude and temperature stability. Can support 3 times the weight of a Boeing-747 aircraft tire. **Each tire used only once.**

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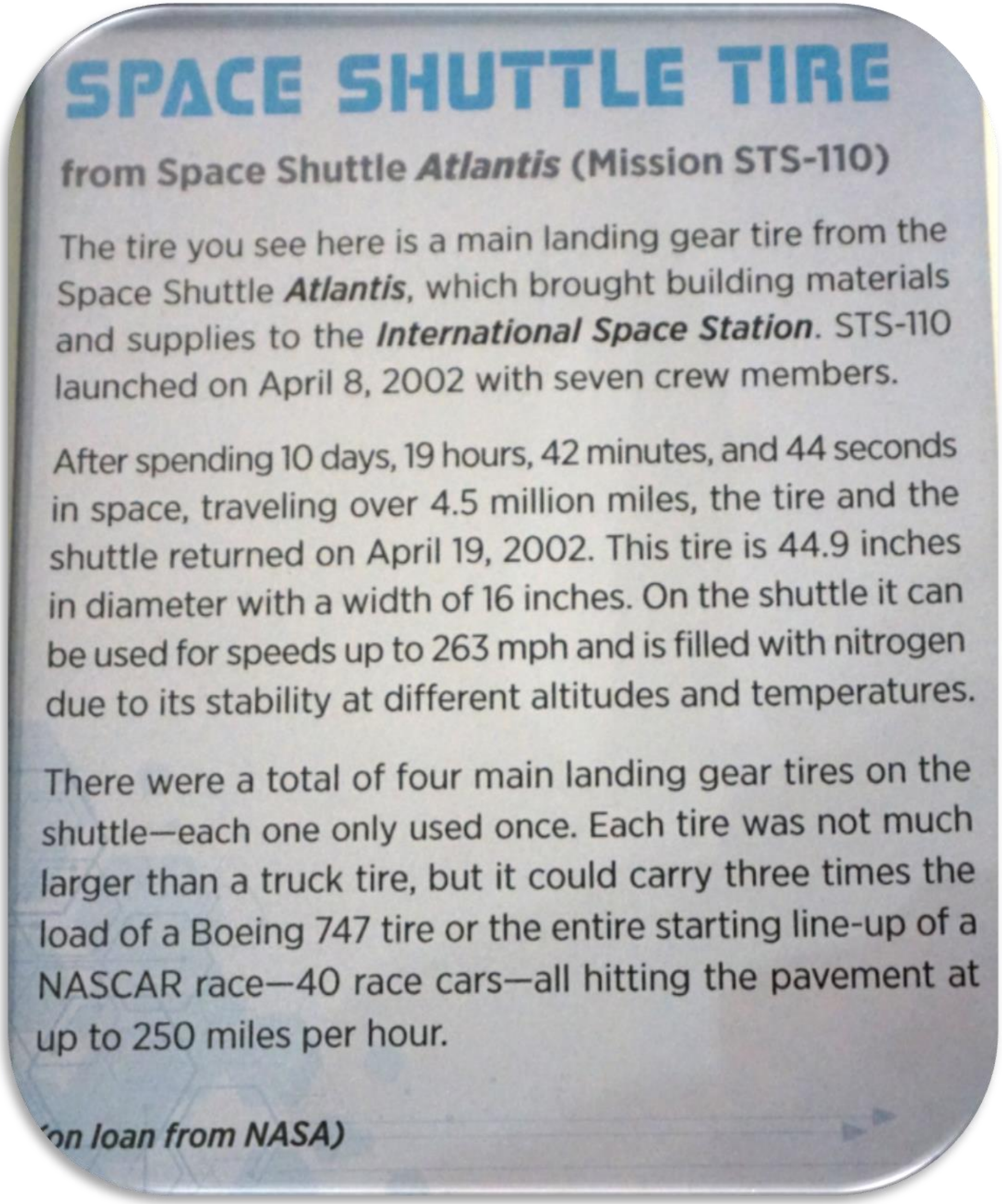
Space Gallery



SPACE SHUTTLE TIRE

from Space Shuttle *Atlantis* (Mission STS-110)

The tire you see here is a main landing gear tire from the Space Shuttle ***Atlantis***, which brought building materials and supplies to the ***International Space Station***. STS-110 launched on April 8, 2002 with seven crew members.

After spending 10 days, 19 hours, 42 minutes, and 44 seconds in space, traveling over 4.5 million miles, the tire and the shuttle returned on April 19, 2002. This tire is 44.9 inches in diameter with a width of 16 inches. On the shuttle it can be used for speeds up to 263 mph and is filled with nitrogen due to its stability at different altitudes and temperatures.

There were a total of four main landing gear tires on the shuttle—each one only used once. Each tire was not much larger than a truck tire, but it could carry three times the load of a Boeing 747 tire or the entire starting line-up of a NASCAR race—40 race cars—all hitting the pavement at up to 250 miles per hour.

(on loan from NASA)

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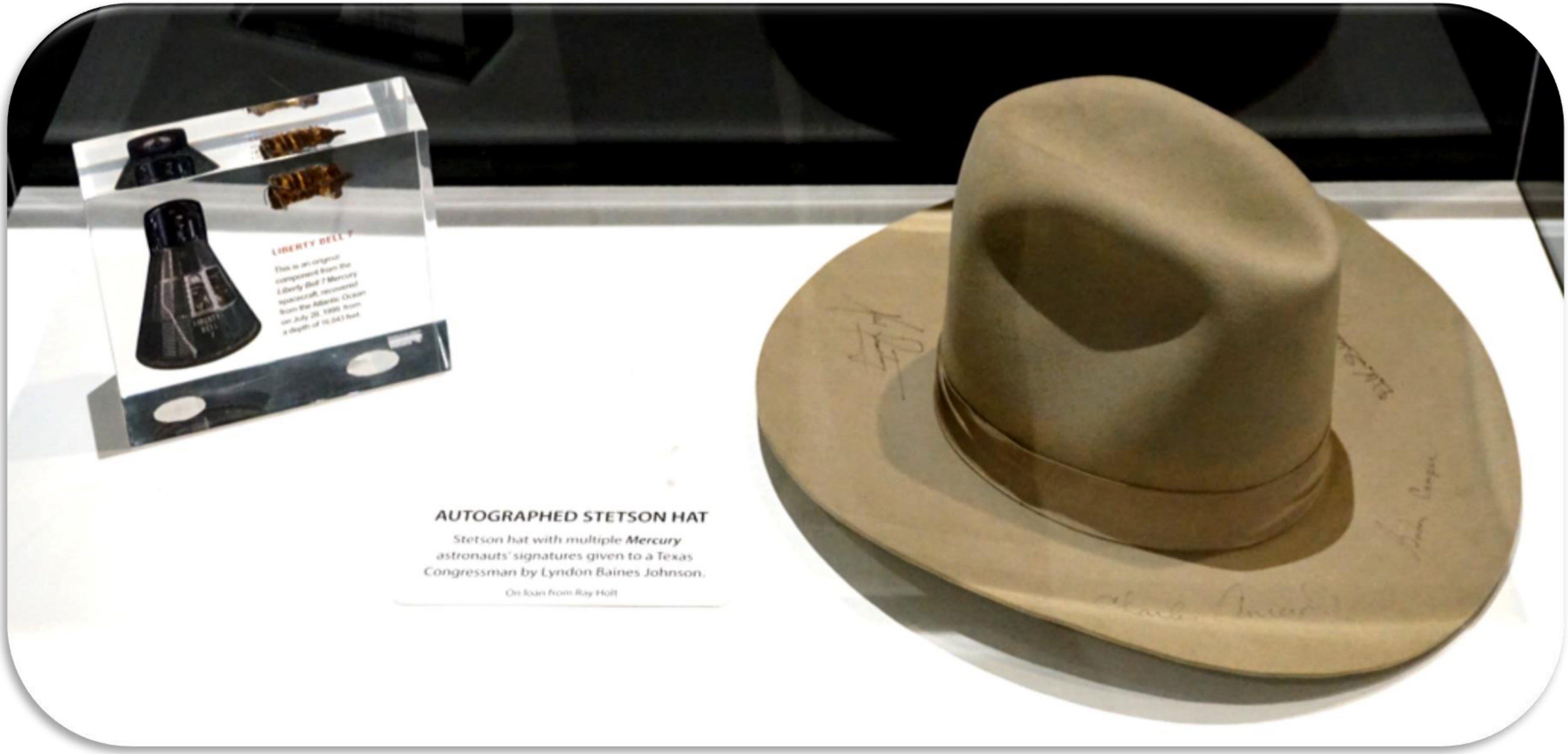
Space Gallery


LIBERTY BELL 7
This is an original component from the Liberty Bell 7 Mercury spacecraft, recovered from the Atlantic Ocean on July 20, 1999 from a depth of 16,043 feet.
AUTOGRAPHED STETSON HAT
Stetson hat with multiple Mercury astronauts' signatures given to a Texas Congressman by Lyndon Baines Johnson.
On loan from Ray Holt

Key Points: **Stetson hat (Original)** signed by several Mercury Astronauts, including **Neil Armstrong.** Given by then Senator Lyndon B Johnson to a Texas Congressman.

On left: **Project Mercury component** from the ***Liberty Bell 7*** spacecraft recovered from a depth of 16,043 feet in the Atlantic Ocean.

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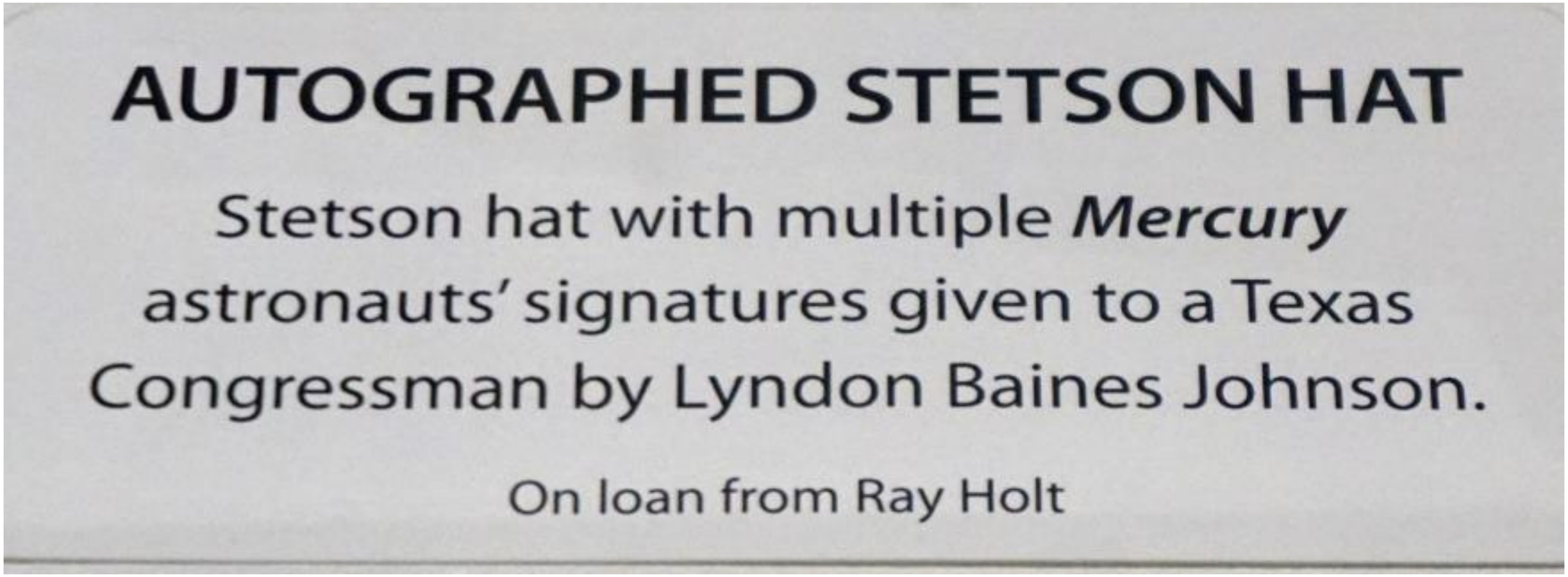
Space Gallery



AUTOGRAPHED STETSON HAT

Stetson hat with multiple *Mercury* astronauts' signatures given to a Texas Congressman by Lyndon Baines Johnson.

On loan from Ray Holt

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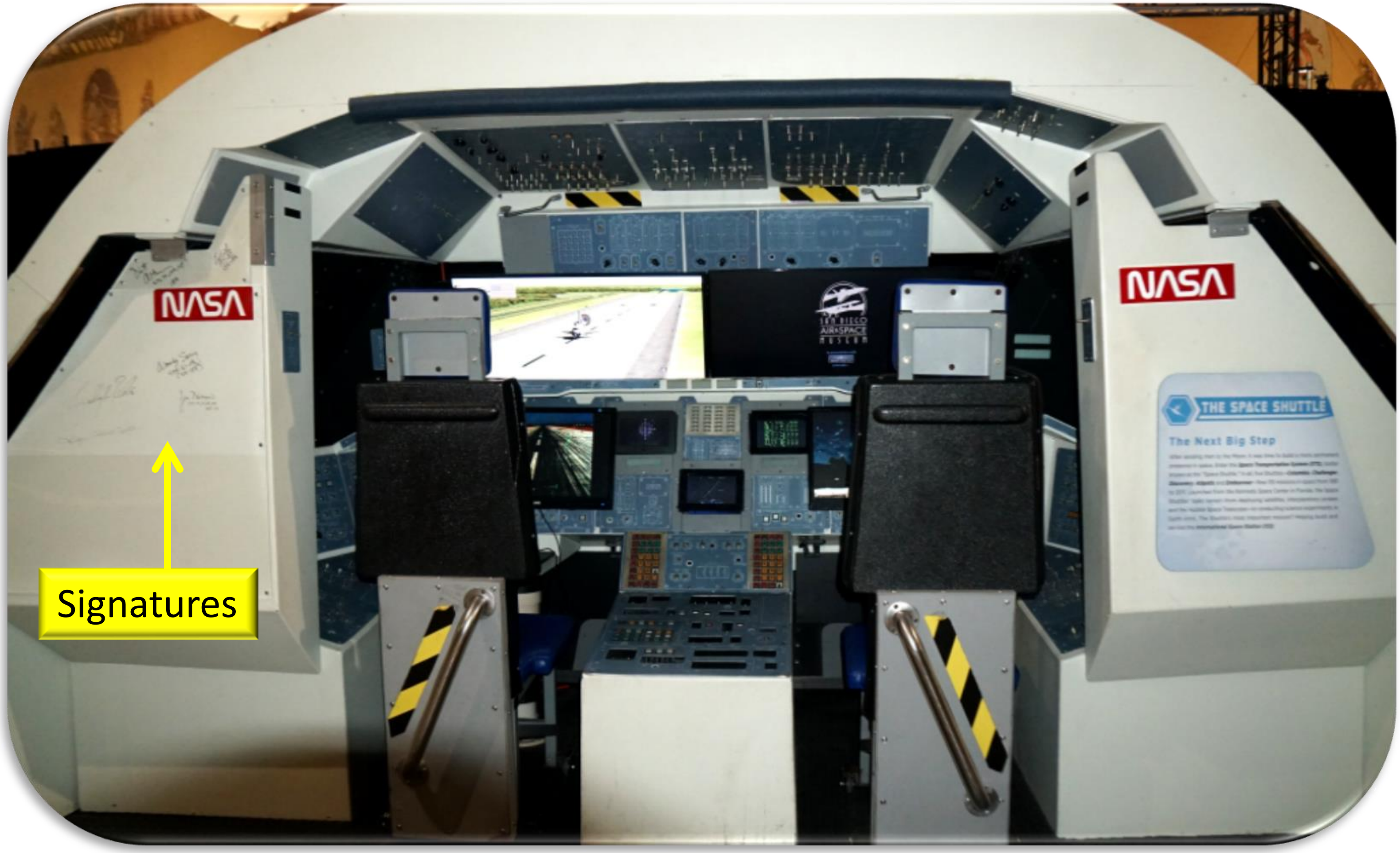
Space Gallery


NASA
NASA
THE SPACE SHUTTLE
The Next Big Step
Signatures

Key Points: **Space Shuttle Procedural and Flight Simulator (Original)** – Used in the early stages of the Shuttle Space Transportation System (STS) to train Astronauts. Signed by several NASA Astronauts (**Sally Kristen Ride, Sherwood Clark "Woody" Spring, James Hansen "Jim" Newman, Scott Douglas "Scooter" Altman, Edward T. Lu**).

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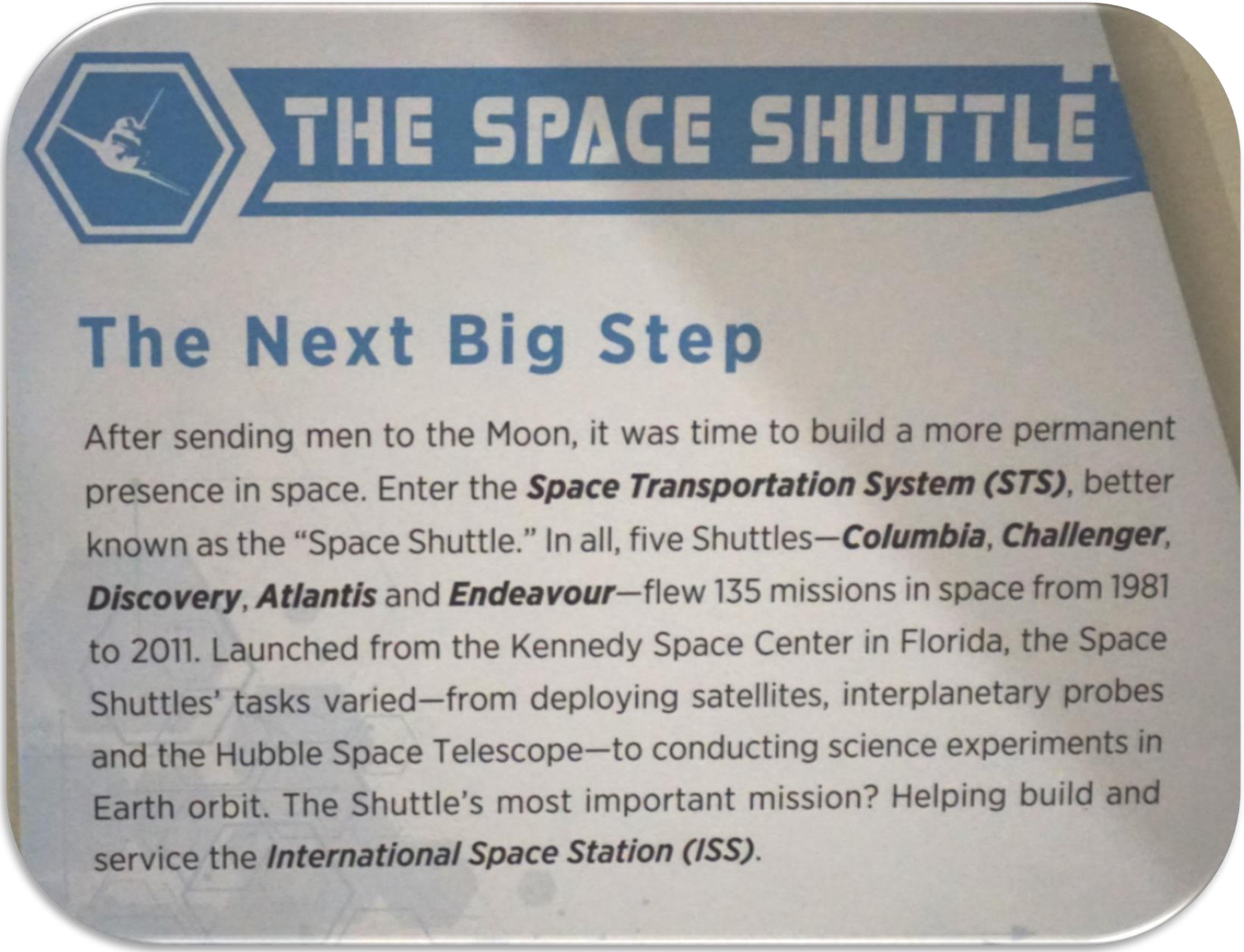
Space Gallery



THE SPACE SHUTTLE

The Next Big Step

After sending men to the Moon, it was time to build a more permanent presence in space. Enter the ***Space Transportation System (STS)***, better known as the “Space Shuttle.” In all, five Shuttles—***Columbia***, ***Challenger***, ***Discovery***, ***Atlantis*** and ***Endeavour***—flew 135 missions in space from 1981 to 2011. Launched from the Kennedy Space Center in Florida, the Space Shuttles’ tasks varied—from deploying satellites, interplanetary probes and the Hubble Space Telescope—to conducting science experiments in Earth orbit. The Shuttle’s most important mission? Helping build and service the ***International Space Station (ISS)***.

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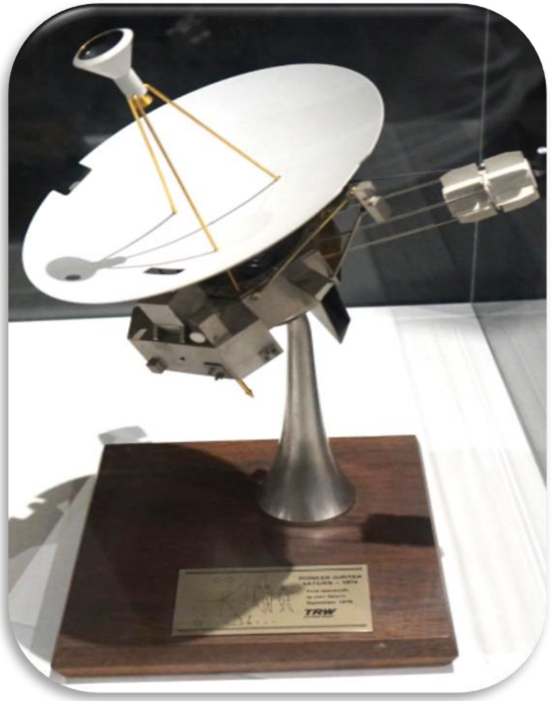
Space Gallery



Pioneer Spacecraft. Identical exploration space vehicles dedicated to go where no one has gone before … **and take pictures**. Both radioed earth decades beyond their design lifetime (now inactive) and are both now in intergalactic space.

Vanguard Satellite. 4th satellite launched into earth orbit (2nd by U.S.). **Oldest satellite still in space**, launched Mar 7, 1958. 1st solar powered satellite; 6.3" diameter.

Pioneer 10: 1st through **asteroid belt** between Mars and Jupiter. 1st to **fly by Jupiter**, discovered new rings and moons; **1st to travel beyond all our planets and enter intergalactic space**.

Pioneer 11: 2nd to fly by Jupiter; 1st to fly by **Saturn**, discovered new rings and moons.

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Planetary Exploration Probes

Name	Launched	Distance (AU*) (as of 2020)	Speed (km/s)
Pioneer 10	1972	125	12
Pioneer 11	1973	103	11
Voyager 1	1977	148	17
Voyager 2	1977	123	15
New Horizons	2006	46	16

Key Points: **Planetary Exploration Probes.** Of the major spacecraft, ***Voyager 1*, *Voyager 2***, and ***New Horizons*** are still functioning and are regularly contacted by radio communication, while ***Pioneer 10*** and ***Pioneer 11*** are now inactive. In addition to these spacecraft, some third stages and de-spin weights are leaving the Solar System, assuming they continue on their trajectories. These objects are *leaving* the Solar System because their velocity and direction are taking them away from the Sun, and at their distance from the Sun, its gravitational pull is not sufficient to pull these objects back or into orbit. They are not impervious to the gravitational pull of the Sun and are being slowed, but are still traveling in excess of escape velocity to leave the Solar System and coast into intergalactic space.

*AU - Astronomical Unit; distance between the earth and the sun (i.e., about 93 million miles).

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SDASM Docent ***Ron Pitcher*** points to the plaque he loaned to SDASM. He was involved with both Vanguard and Pioneer missions.

Key Points: The *Pioneer* Plaques are 6” X 9” gold-anodized aluminum plaques. They were placed aboard the *Pioneer 10* and *Pioneer 11* spacecraft in case either spacecraft is intercepted by intelligent extraterrestrial life (i.e., they will see human images and where the spacecraft originated from).

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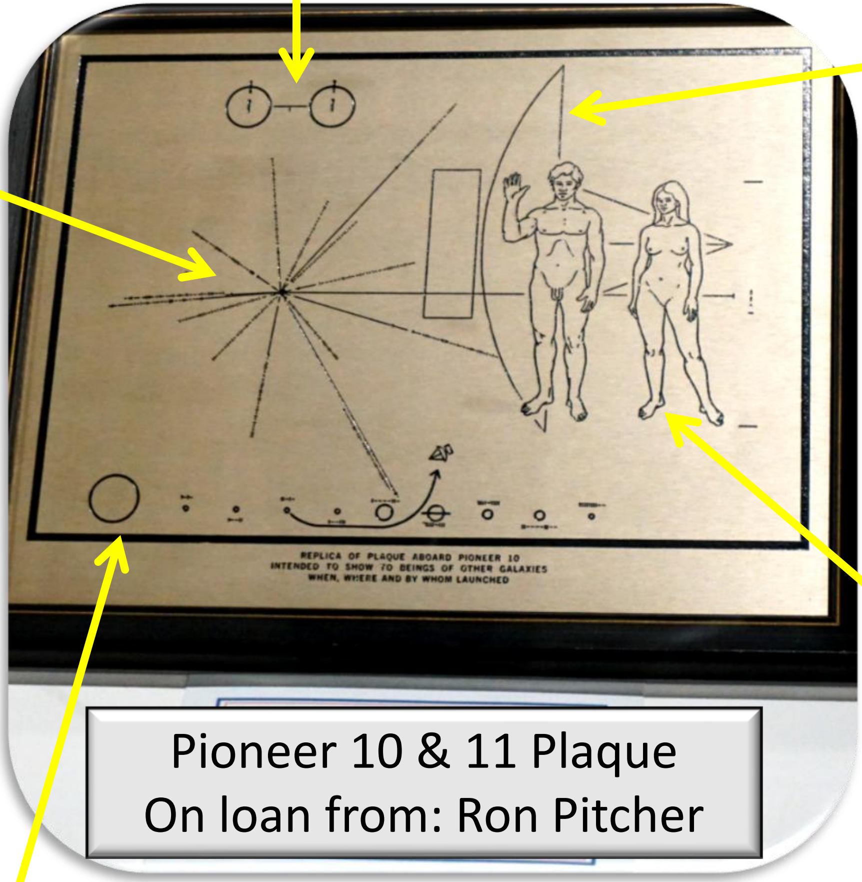
Space Gallery


REPLICA OF PLAQUE ABOARD PIONEER 10
INTENDED TO SHOW TO BEINGS OF OTHER GALAXIES
WHEN, WHERE AND BY WHOM LAUNCHED

Pioneer 10 & 11 Plaque
On loan from: Ron Pitcher

Hyperfine transition of neutral hydrogen - Establishes time and length units used in the other symbols.

Sun and galactic landmarks - long binary numbers (unique periods of pulsars) and direction (using hydrogen spin-flip transition frequency) as the unit. Since these pulsar periods will change over time, the epoch of the launch can be calculated from these values and thru triangulation of the pulsars will show the galactic location of our Sun.

Silhouette of the spacecraft - Behind the human figures, the silhouette of the Pioneer spacecraft is shown in the same scale so that the size of the human beings can be deduced by measuring the spacecraft.

Figures of a man and a woman - Based on drawings by Leonardo da Vinci, to show the appearance of our species.

Carl Sagan participated in the plaque design.

Solar System - Schematic diagram of our Solar System w/trajectory of Pioneer 10 & 11 shown.

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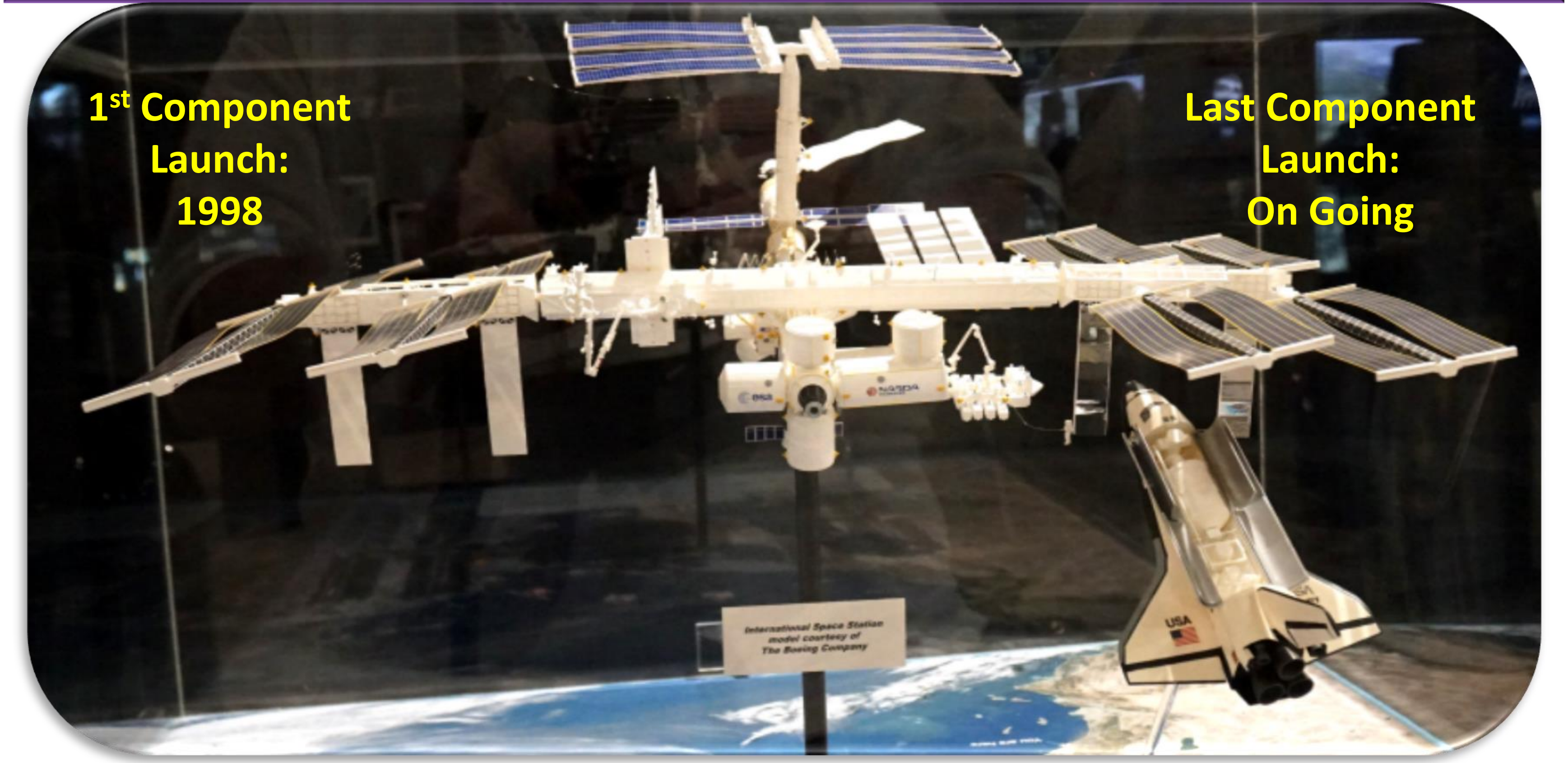
Space Gallery


International Space Station model courtesy of The Boeing Company

1st Component
Launch:
1998

Last Component
Launch:
On Going

Key Points: **International Space Station** (**ISS**) (Model) a modular space station in low Earth orbit. A multinational collaborative project between the U.S., Russia, Japan, Europe, and Canada. The ISS serves as a **microgravity and space environment research laboratory** conducting scientific research in astrobiology, astronomy, meteorology, physics, and other fields. The ISS is suited for testing the spacecraft systems and equipment required for possible future long-duration missions to the Moon and Mars.

This: ISS model courtesy **Boeing Co.**. Shuttle by **Tony Beres**.

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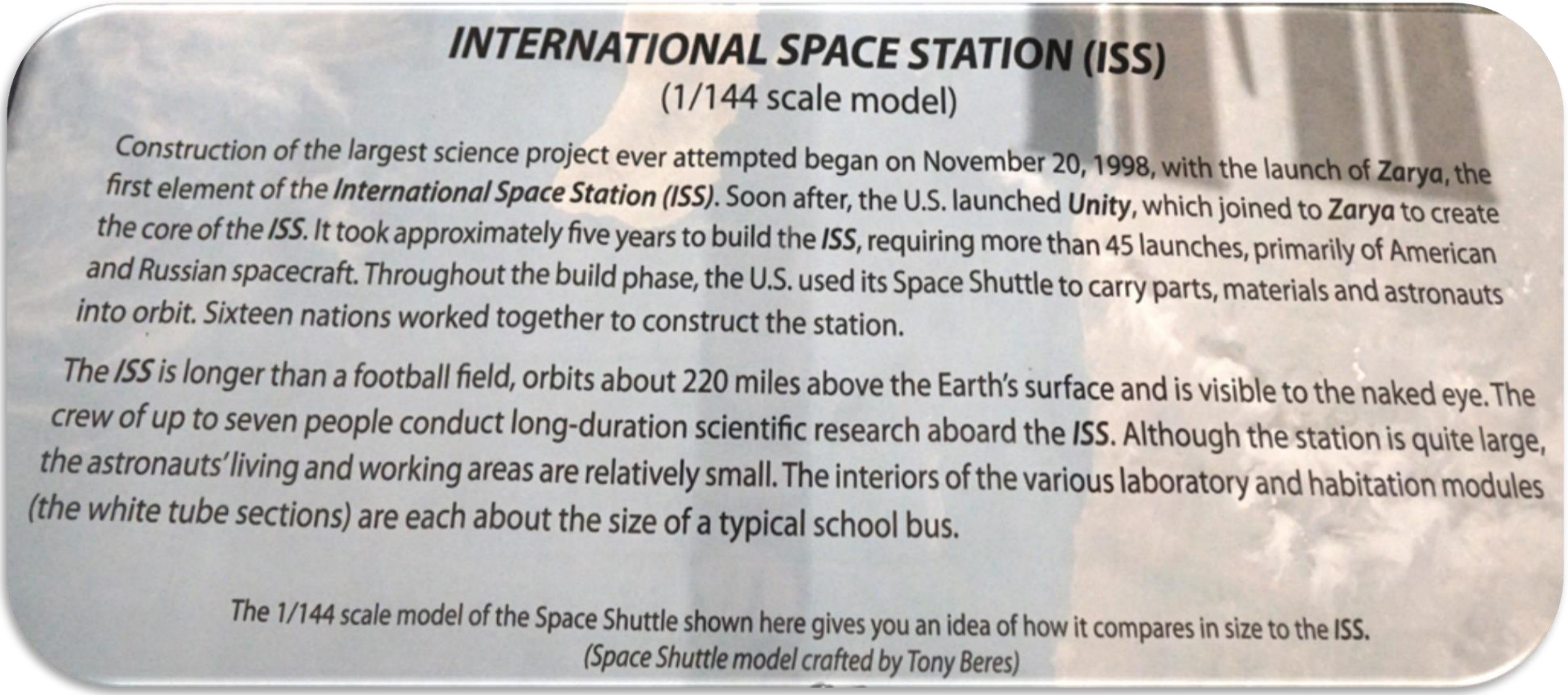
Space Gallery



INTERNATIONAL SPACE STATION (ISS)

(1/144 scale model)

Construction of the largest science project ever attempted began on November 20, 1998, with the launch of **Zarya**, the *first element of the* ***International Space Station (ISS)***. Soon after, the U.S. launched **Unity**, which joined to **Zarya** to create *the core of the* ***ISS***. *It took* approximately five years to build the ***ISS***, requiring more than 45 launches, primarily of American *and Russian spacecraft.* Throughout the build phase, the U.S. used its Space Shuttle to carry parts, materials and astronauts *into orbit. Sixteen nations worked together* to construct the station.

The ***ISS*** *is* longer than a football field, orbits about 220 miles above the Earth's surface and is visible to the naked eye. The *crew of up to seven people* conduct long-duration scientific research aboard the **ISS**. Although the station is quite large, *the astronauts' living and working* areas are relatively small. The interiors of the various laboratory and habitation modules *(the white tube sections)* are each about the size of a typical school bus.

The 1/144 scale model of the Space Shuttle shown here gives you an idea of how it compares in size to the **ISS**.

(Space Shuttle model crafted by Tony Beres)

Extra Info: **ISS** is the largest artificial object in space and is regularly **visible to the naked** eye from Earth's surface (tracking cell phone app available). Average **orbit 250 mi @ 17,100 mph**; circles Earth every **93 minutes**. Consists of **9 pressurized habitation modules** with 5 more planned. **Current crew of 6**. Over 239 astronauts from 19 different nations have visited the station. The station is expected to operate until **2030**. **About 240 ft long and 358 ft wide.**

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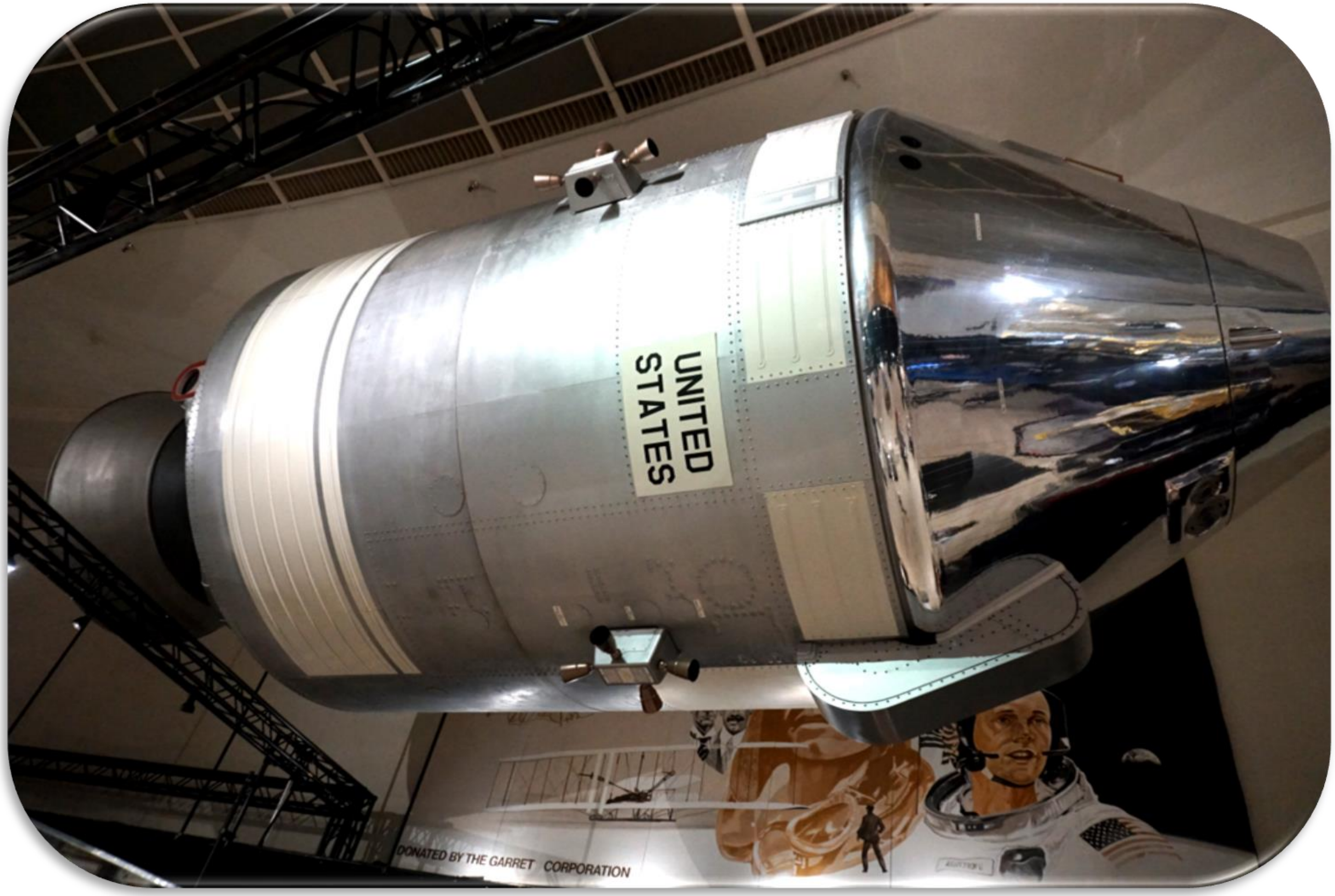
Space Gallery


UNITED STATES
DONATED BY THE GARRET CORPORATION

Key Points: (Full scale Mock-up) - **Apollo Command** and **Service Module**. The service module provided **oxygen, water and electrical generation to the Command Module for the flight to and from the Moon.**

This: Built by North American Rockwell Corporation, Space Division, Downey, California.

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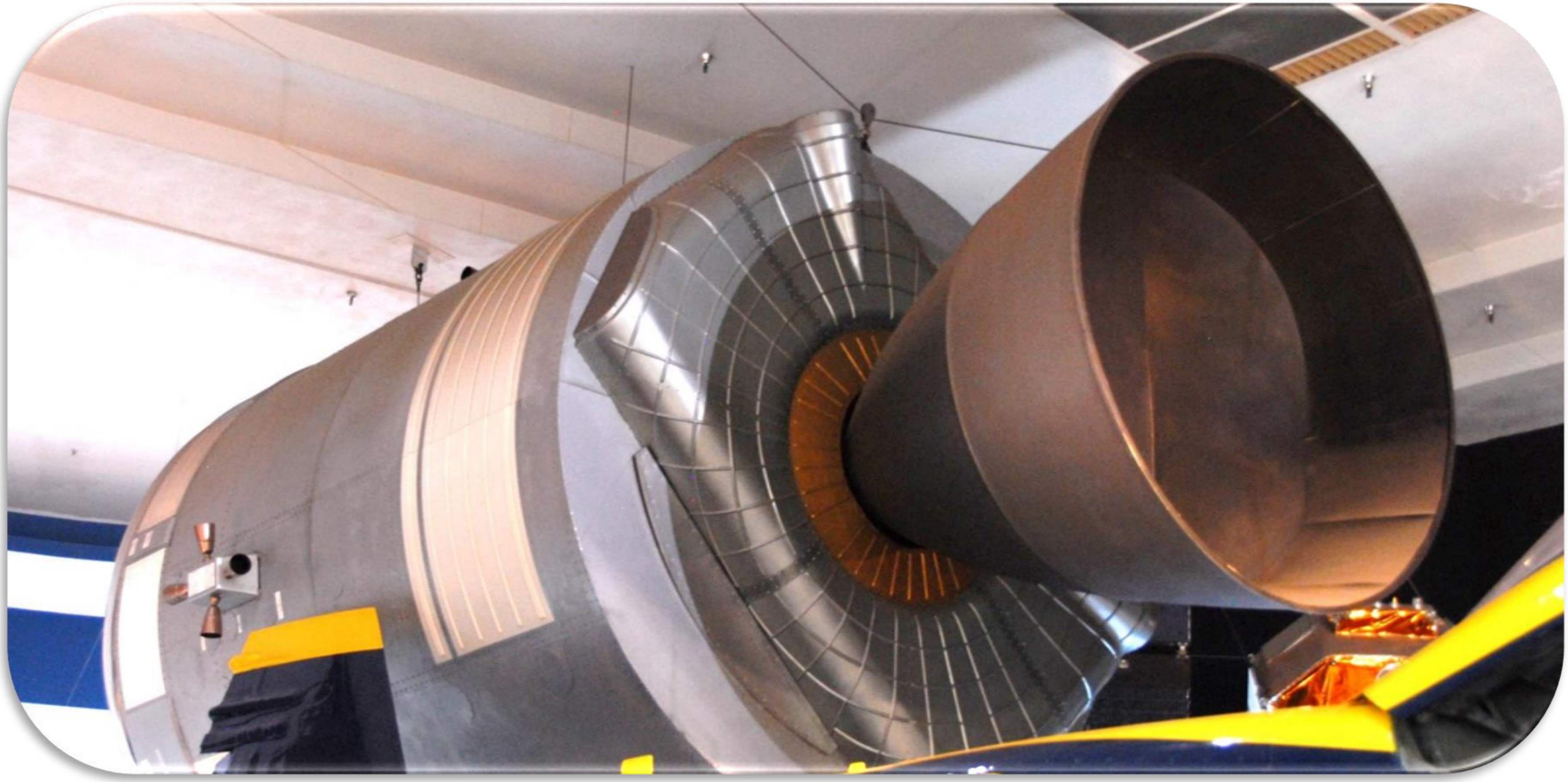
Space Gallery



Key Points: View of the aft end of the *Apollo Service Module* showing the Propulsion System Nozzle of the 20,500 lb thrust (Liquid) engine. It was 24’ 3 “ long and 12’ 8” in diameter. It weighed 54,074 lbs and contained one main Service Propulsion System engine, four RCS Quad engines (Liquid), and fuel for all 5 engines.

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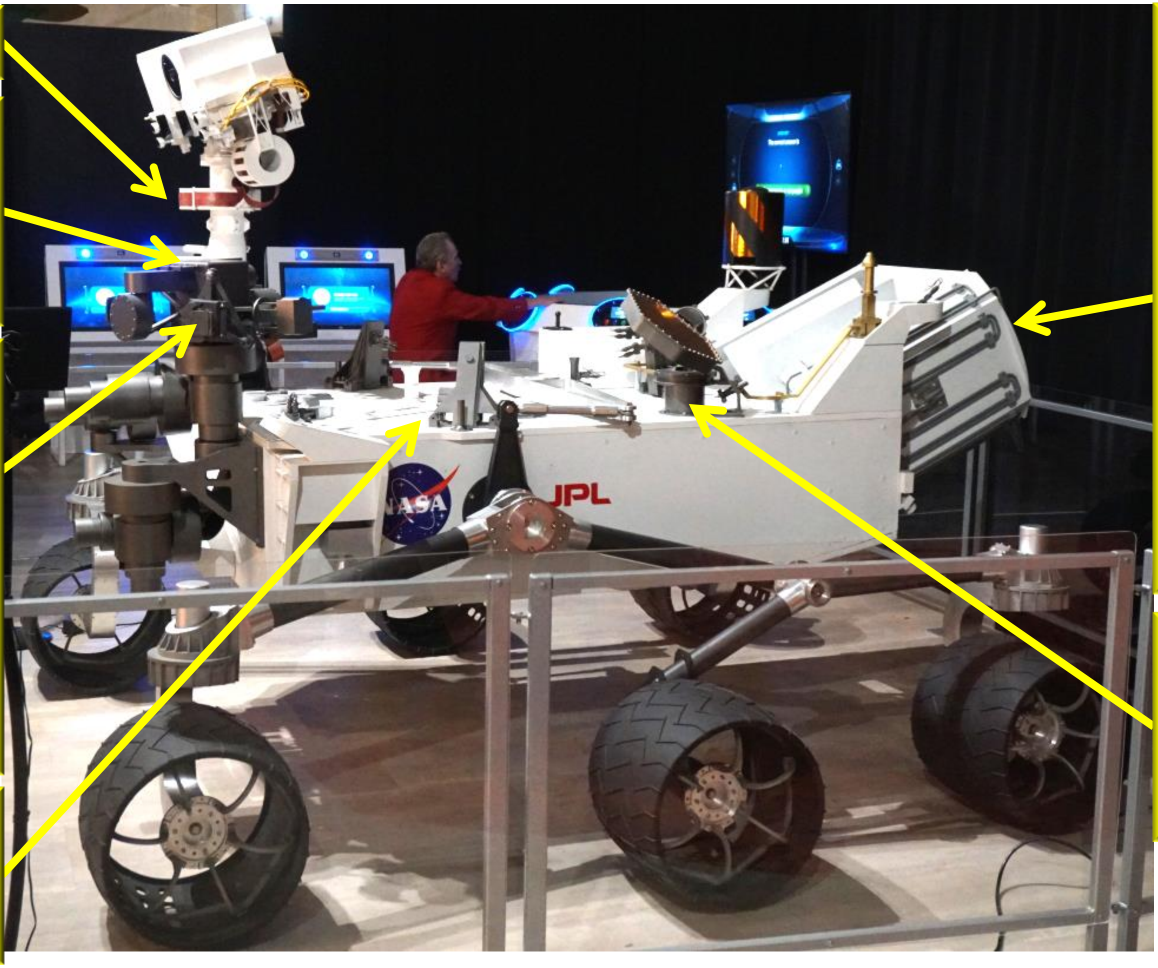
Space Gallery



Weather Station

Rover Environmental Monitoring Station (REMS).

Robotic Arm turret:

- Hand Lens Imager.
- Particle X-ray Spectrometer.
- Drill and Brush.
- Sieves & scoop.

Radiation Assessment Detector.

Plutonium dioxide power source – which converts heat into electricity. **Min life - 14 yrs.** 110 watts elect. & 2000 watts thermal power (10.6 lbs of P-238).

X-Band Low Gain Antenna to receive data (directional).

Key Points: **Curiosity Mars Rover (**Full scale mock-up**),** launched Nov 26, 2011; landed on Mars Aug 6, 2012 (**8 months, 10 days for 350 million mile trip**). *Curiosity* weighs **1982 lb.** and is **still operational** on Mars (as of Oct, 2020). Designed for a **1.88 year mission**, it has operated for **over 8 years**.

This: On loan from the **Jet Propulsion Lab**, Pasadena, CA.

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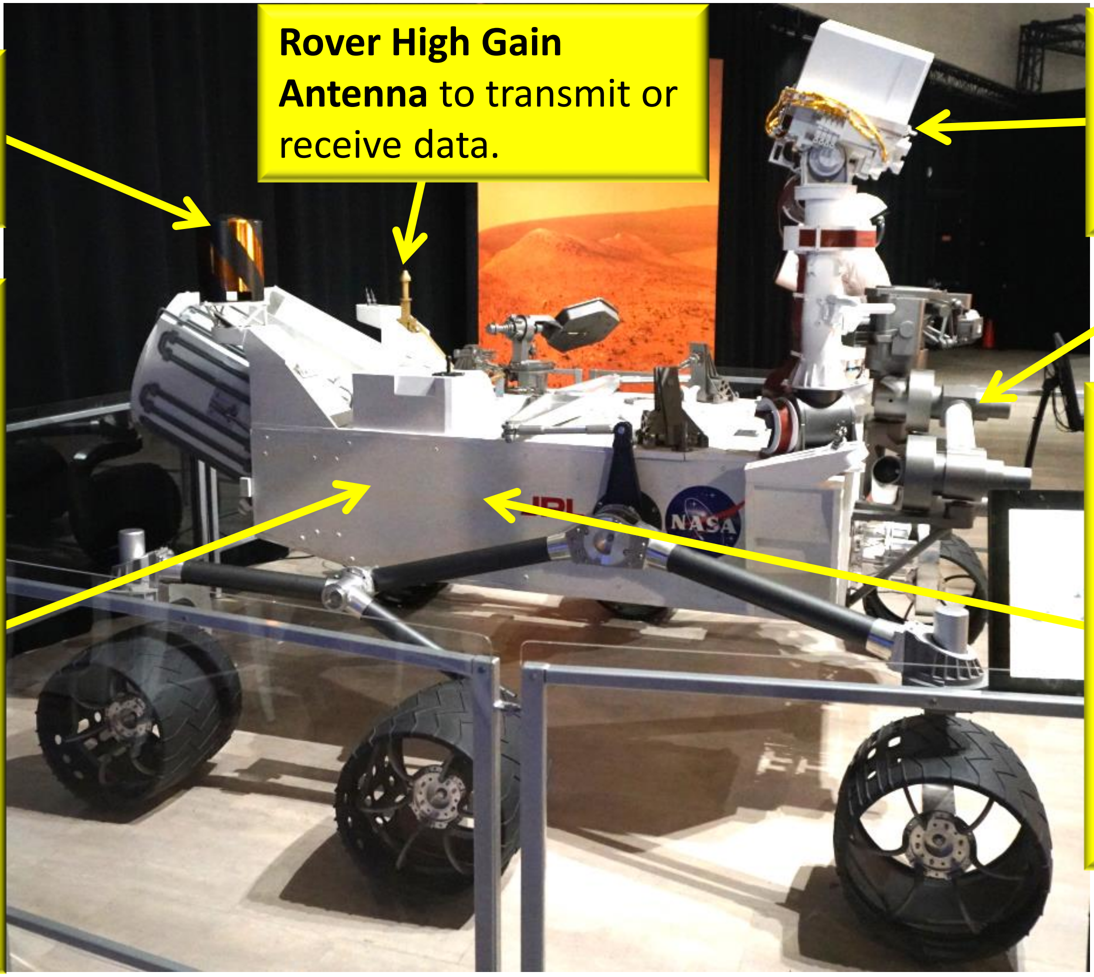
Space Gallery



UHF antenna for primary data transmissions.

Rover High Gain Antenna to transmit or receive data.

Mast – Multiple cameras and scientific instruments.

Robotic Arm

Inside chassis:
Chemistry Lab - to analyze rock and soil samples for organics.
Neutron Detector - to detect water in rock and soil.
Radiation Detector - Measures radiation from sun, supernovae and other sources.

Computers inside: 2 identical computers with 256 kB EEPROM, 256 MB DRAM & 2 GB flash memory. Can execute 400 million instructions per second.

Key Points: **Two UHF radios** for data communications with orbital relay satellite's or directly to earth. **One way radio transmission time** varies between Mars and Earth from **4 to 24 minutes**, depending upon distance between the planets. Max rover speed is 7.5 feet per minute, but **averages 1.6 feet per minute under automatic navigation**. *Curiosity* Rover has covered 14.27 miles across Mars as of Jul 22, 2020.

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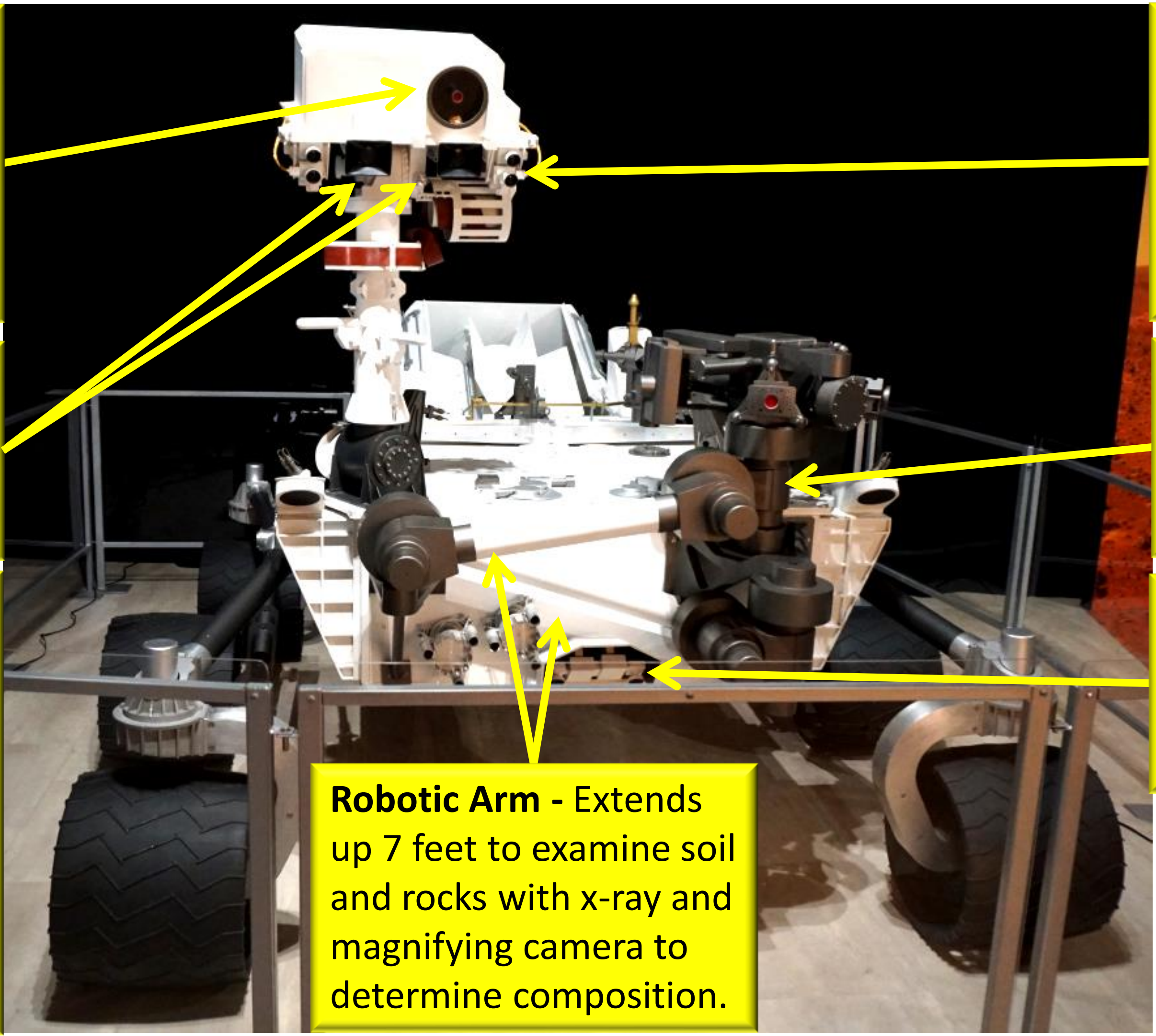
Space Gallery



Chemcam - laser burns rocks for analyses of chemical elements by camera.

2 Mast cameras – Color images and aid in navigation.

Note: Curiosity's **design is basis** for follow-on rover ***Perseverance*** (and ***Ingenuity* Helicopter**), launched **Jul 30, 2020**.

4 Color cameras - (stereo, two on each side) take color pictures and movies in 3-D.

Instrument package - on end of robotic arm.

2 Front Hazard Cameras - Aid in autonomic navigation

Robotic Arm - Extends up 7 feet to examine soil and rocks with x-ray and magnifying camera to determine composition.

Key Points: **Total cameras: 17;** Hazard Cams (8), Navigation Cams (4), Mast Cams (2), Mars Hand Lens Imager (1), Mars Descent Imager (1), and Chemical Cam (1).

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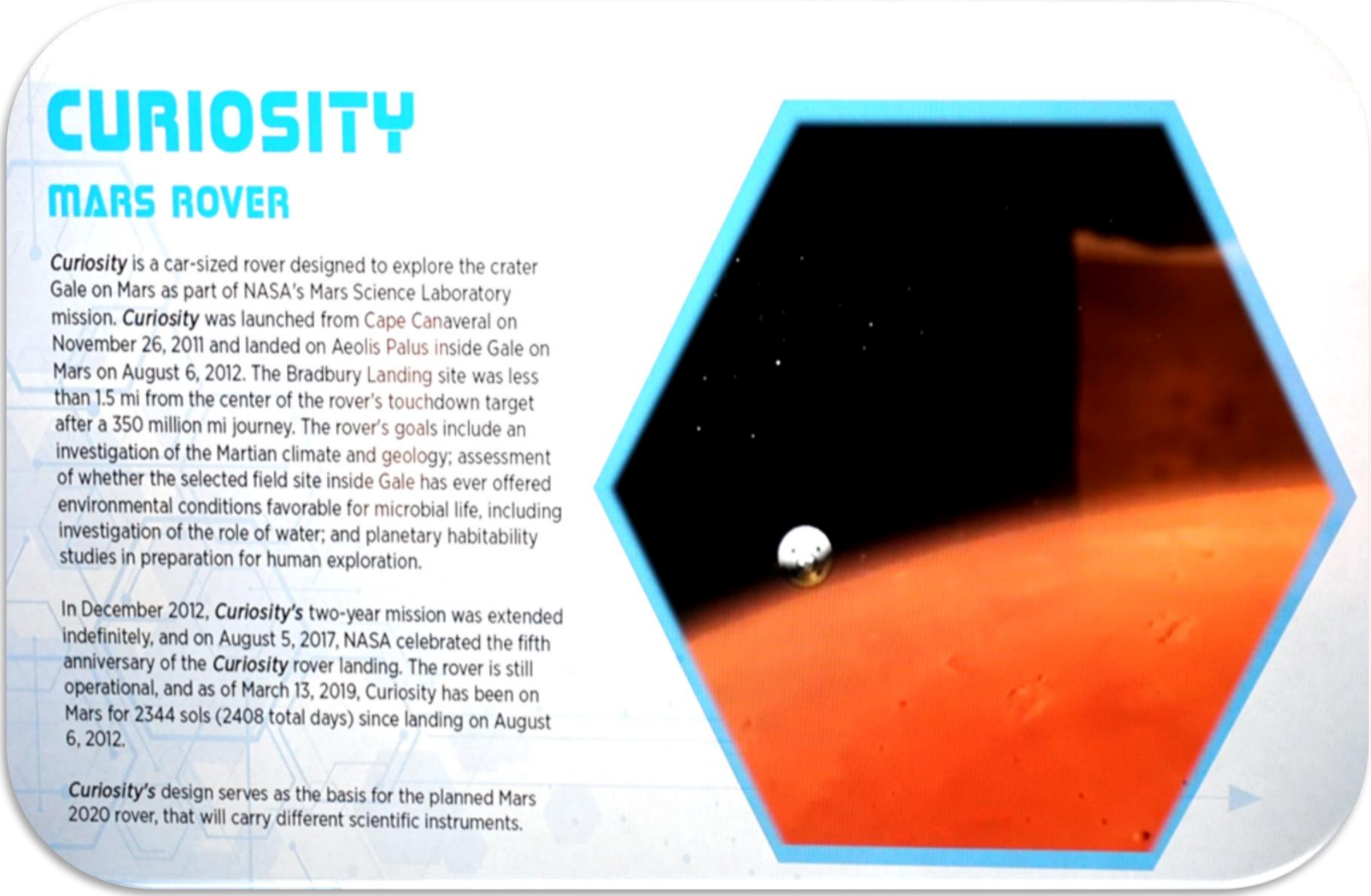
Space Gallery



CURIOSITY

MARS ROVER

Curiosity is a car-sized rover designed to explore the crater Gale on Mars as part of NASA's Mars Science Laboratory mission. ***Curiosity*** was launched from Cape Canaveral on November 26, 2011 and landed on Aeolis Palus inside Gale on Mars on August 6, 2012. The Bradbury Landing site was less than 1.5 mi from the center of the rover's touchdown target after a 350 million mi journey. The rover's goals include an investigation of the Martian climate and geology; assessment of whether the selected field site inside Gale has ever offered environmental conditions favorable for microbial life, including investigation of the role of water; and planetary habitability studies in preparation for human exploration.

In December 2012, ***Curiosity's*** two-year mission was extended indefinitely, and on August 5, 2017, NASA celebrated the fifth anniversary of the ***Curiosity*** rover landing. The rover is still operational, and as of March 13, 2019, Curiosity has been on Mars for 2344 sols (2408 total days) since landing on August 6, 2012.

Curiosity's design serves as the basis for the planned Mars 2020 rover, that will carry different scientific instruments.

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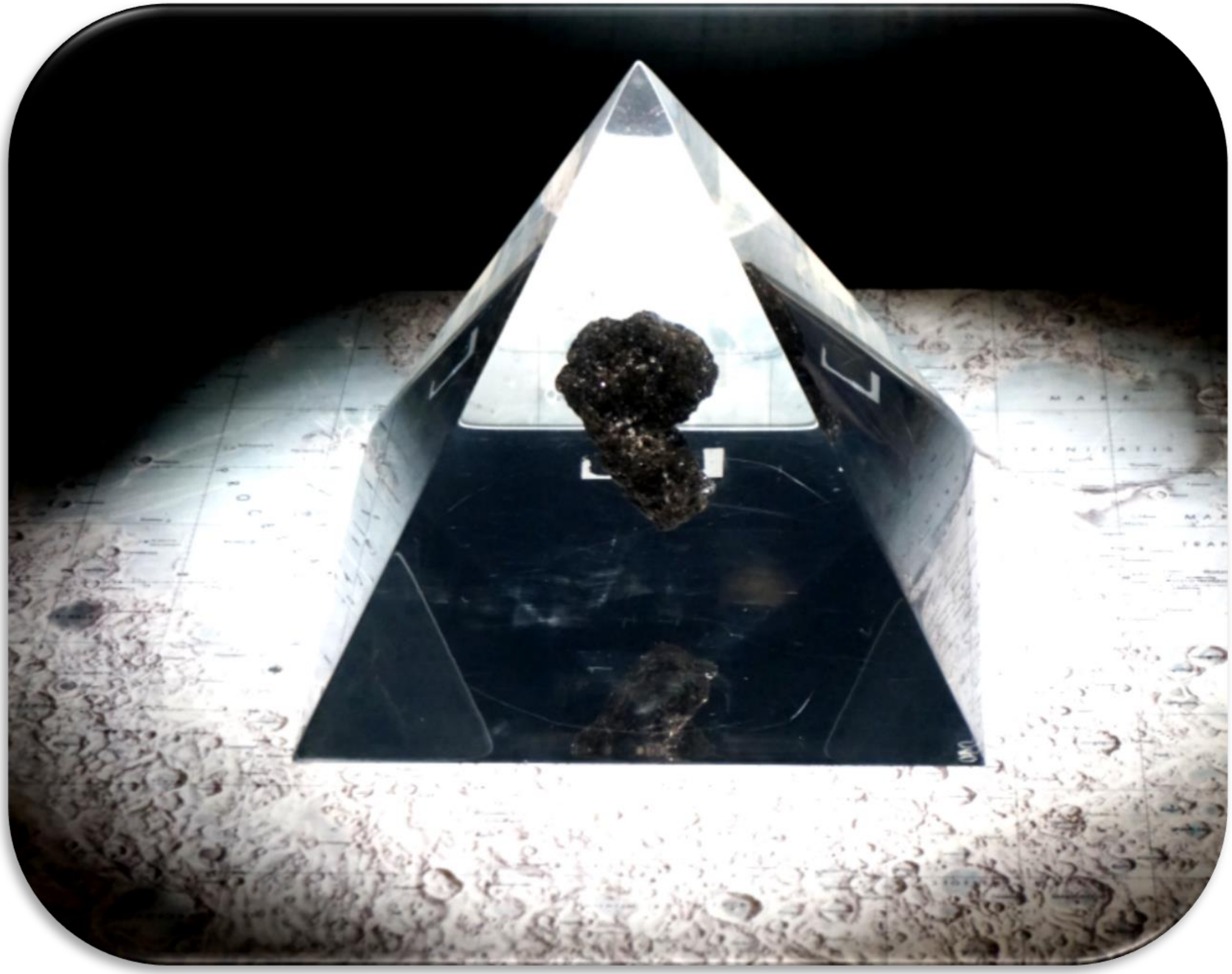
Space Gallery



Key Points: **Moon rock**, (**original**). Brought to earth by **Apollo 17** astronauts. Approximately 9.9 grams (.35 oz). A total of **881 lbs** of lunar samples returned throughout the six Apollo missions that landed on the Moon. NASA assessed value, in 2018 dollars, of this sample is **$2,970,000**.

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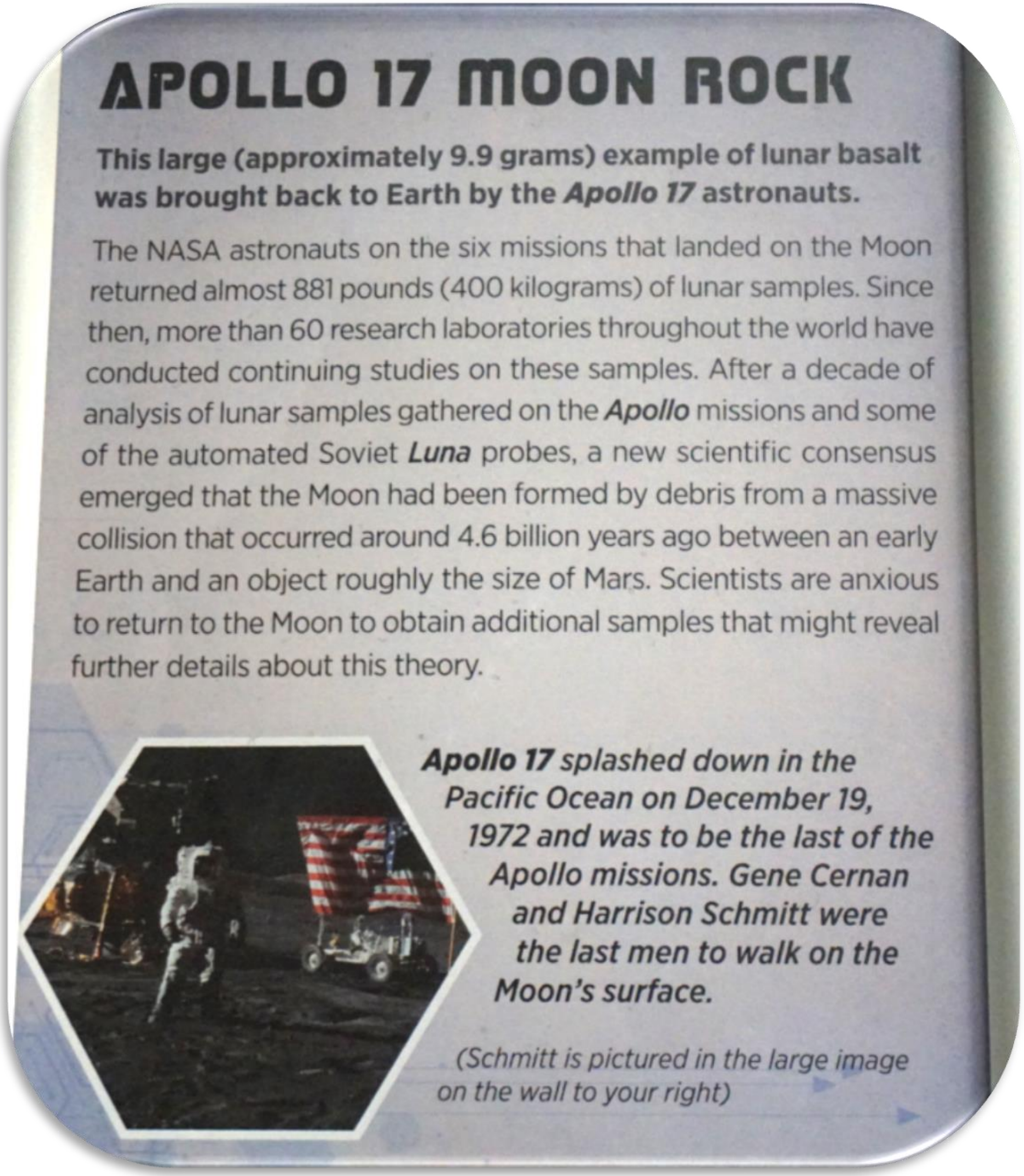
Space Gallery



APOLLO 17 MOON ROCK

This large (approximately 9.9 grams) example of lunar basalt was brought back to Earth by the *Apollo 17* astronauts.

The NASA astronauts on the six missions that landed on the Moon returned almost 881 pounds (400 kilograms) of lunar samples. Since then, more than 60 research laboratories throughout the world have conducted continuing studies on these samples. After a decade of analysis of lunar samples gathered on the ***Apollo*** missions and some of the automated Soviet ***Luna*** probes, a new scientific consensus emerged that the Moon had been formed by debris from a massive collision that occurred around 4.6 billion years ago between an early Earth and an object roughly the size of Mars. Scientists are anxious to return to the Moon to obtain additional samples that might reveal further details about this theory.

***Apollo 17** splashed down in the Pacific Ocean on December 19, 1972 and was to be the last of the Apollo missions. Gene Cernan and Harrison Schmitt were the last men to walk on the Moon's surface.*

(Schmitt is pictured in the large image on the wall to your right)

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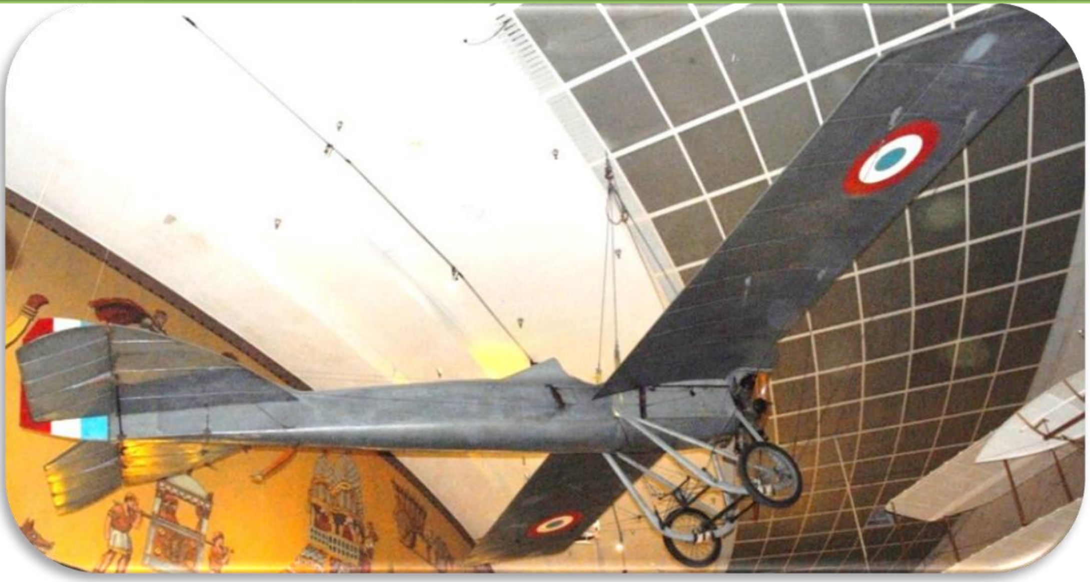
World War I Gallery

1914 to 1918

World War I Gallery



1st flight: 1911
(At least 43 built)

Key Points: **Deperdussin** 1911 Type Militaire (**Original**). The Deperdussin Company, France, built **single-seat racing plane** that heralded the 1st sleek aerodynamic design with a revolutionary **new method of construction**. A "central form" with glued strips of tulip wood over it created the fuselage. The form was removed, leaving the sleek, rounded shell which was strong and light. This was known as a **monocoque fuselage** and is still used on many modern aircraft. **First aircraft to exceed 100mph**, Feb 22, **1912**, near Pau France, **105mph average over 120 miles**.

Extra Info: **Armand Deperdussin**, sent to prison in disgrace. His designer, Louis Béchereau, joined with **Louis Blériot**, to reorganize *Société pour les Appareils Deperdussin* Company as ***Société pour l'Aviation et ses Dérives***, retaining the **SPAD acronym**.

This: Part of the Jean Salis Collection in Paris, donated to the Museum by the Parker Foundation, the Gildred Foundation, and Mr. & Mrs. T. C. Ryan.

Note: The Deperdussin built the same year as Curtiss A-1 Triad, and is more sophisticated than the Triad except the **Deperdussin used wing warping and the Triad had ailerons**.

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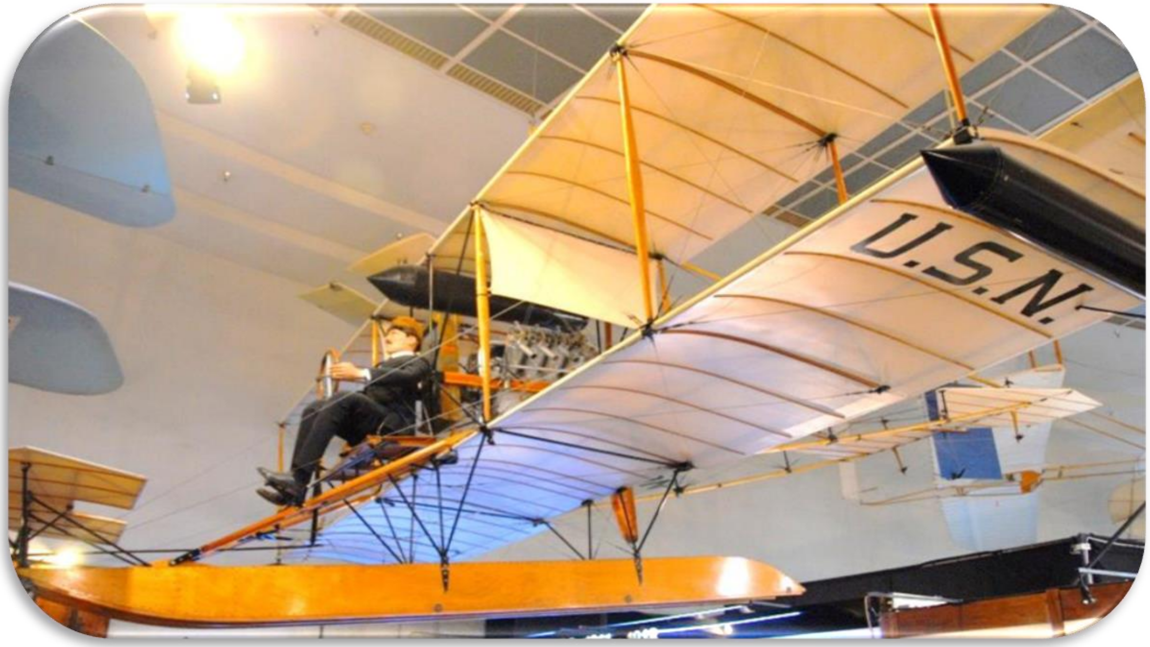

1st flight: 1911
(14 built)

Key Points: **Curtiss A-1 Triad** (Reproduction). **Jan 26, 1911**, Curtiss took off and landed A-1 on **Coronado beach and San Diego Bay**, Navy observers impressed, bought one. **Jul 1, 1911, 1st A-1 delivered to North Island, Lt Ellyson piloted the aircraft and Naval Aviation was born.** **1st production aircraft to use 'aileron'** & 1st aircraft to use **airborne radio; set several speed and endurance records**. A-1 earned Curtiss the 1912 **Collier Trophy** and title "The Father of Naval Aviation". **90 hp liquid cooled Curtiss OX-5 V-8**. **"Triad" because A-1 is land, sea, and air capable.**

Extra Info: 1910, Curtiss established military pilot school on North Island in San Diego and trained Army pilots and Naval Aviator #1 **Theodore Ellyson**, thus North Island became "Birthplace of Naval Aviation" & 1st military aviation school in the US.

This: Built 1981-83 by **Henry Wheeler** and 9 volunteers, at Montgomery Field. **Flown Jan 26, 1984**, on 73rd Ann. of 1st flight, by **Jim Dalby**. **Flown** again **Feb 12, 2011,** on **Centennial of Naval Aviation,** local seaplane pilot **Michael Steele** at the controls (video in WWI section).

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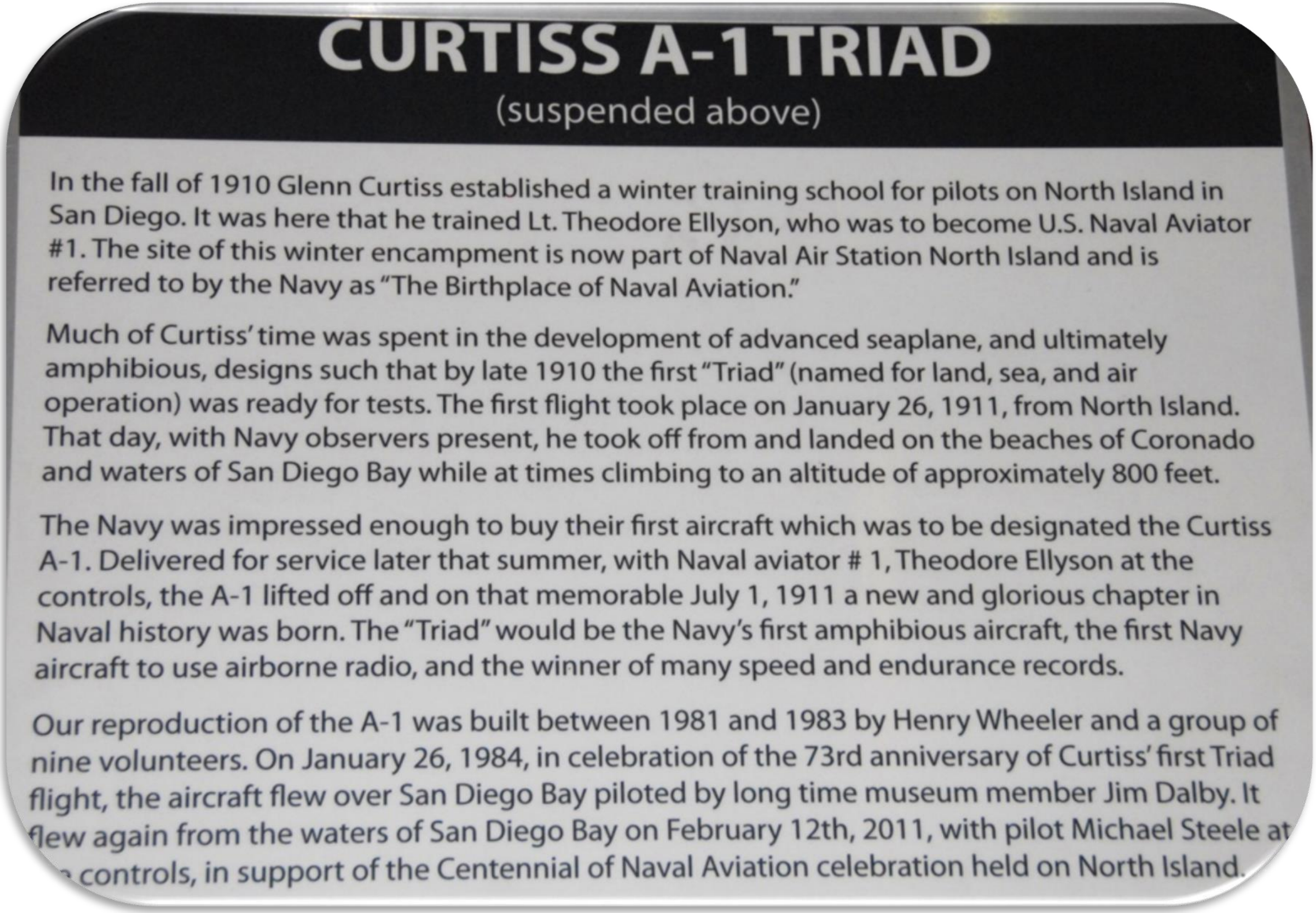

CURTISS A-1 TRIAD

(suspended above)

In the fall of 1910 Glenn Curtiss established a winter training school for pilots on North Island in San Diego. It was here that he trained Lt. Theodore Ellyson, who was to become U.S. Naval Aviator #1. The site of this winter encampment is now part of Naval Air Station North Island and is referred to by the Navy as "The Birthplace of Naval Aviation."

Much of Curtiss' time was spent in the development of advanced seaplane, and ultimately amphibious, designs such that by late 1910 the first "Triad" (named for land, sea, and air operation) was ready for tests. The first flight took place on January 26, 1911, from North Island. That day, with Navy observers present, he took off from and landed on the beaches of Coronado and waters of San Diego Bay while at times climbing to an altitude of approximately 800 feet.

The Navy was impressed enough to buy their first aircraft which was to be designated the Curtiss A-1. Delivered for service later that summer, with Naval aviator # 1, Theodore Ellyson at the controls, the A-1 lifted off and on that memorable July 1, 1911 a new and glorious chapter in Naval history was born. The "Triad" would be the Navy's first amphibious aircraft, the first Navy aircraft to use airborne radio, and the winner of many speed and endurance records.

Our reproduction of the A-1 was built between 1981 and 1983 by Henry Wheeler and a group of nine volunteers. On January 26, 1984, in celebration of the 73rd anniversary of Curtiss' first Triad flight, the aircraft flew over San Diego Bay piloted by long time museum member Jim Dalby. It flew again from the waters of San Diego Bay on February 12th, 2011, with pilot Michael Steele at controls, in support of the Centennial of Naval Aviation celebration held on North Island.

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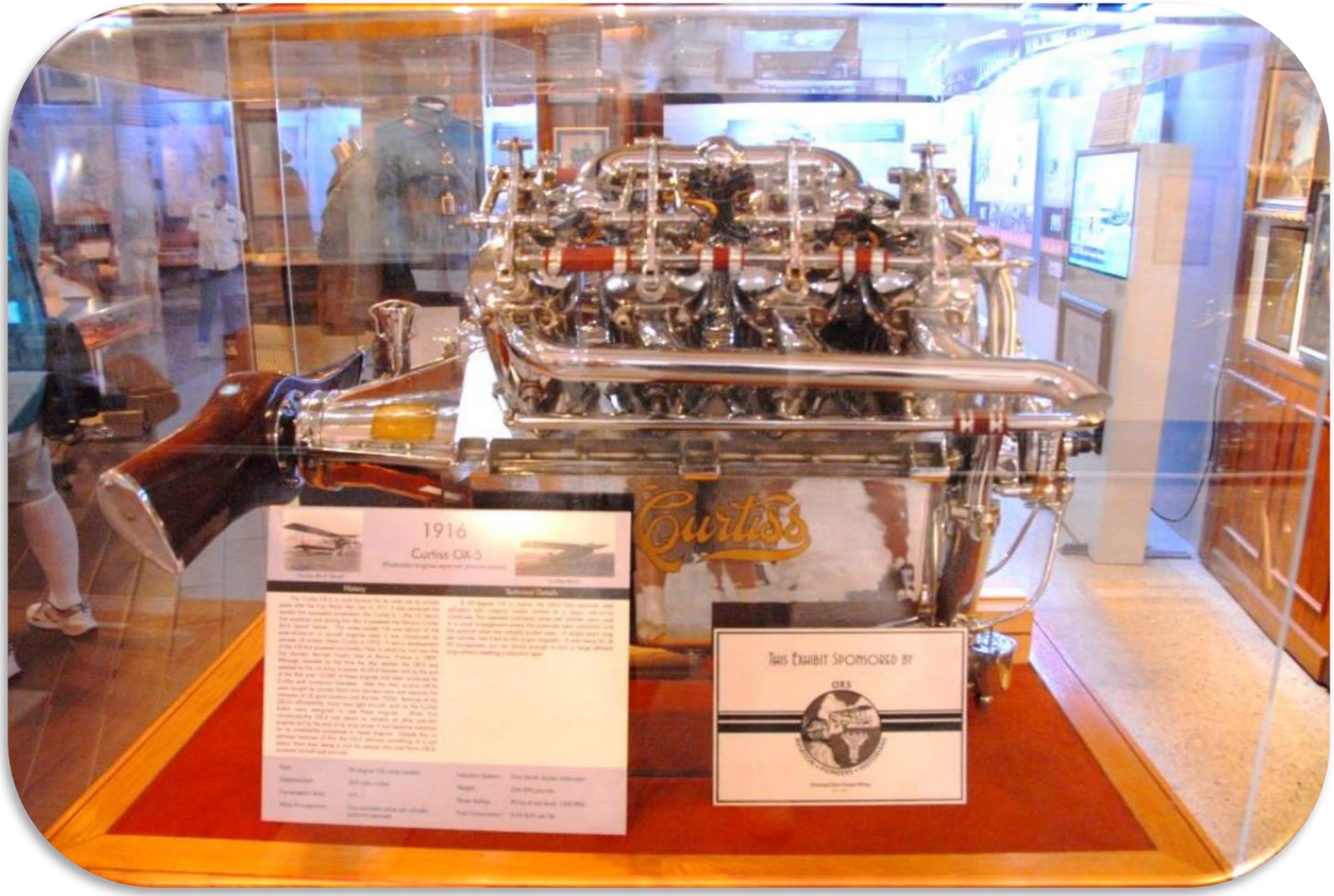
1916
Curtiss OX-5
Curtiss
This Exhibit Sponsored By
OX5

1st produced
1910
(15,000+
Built)

Key Points: **Curtiss OX-5 V-8.** First produced in **1910**. **504 cubic inches and 90 hp** Liquid cooled engine. Used in the Curtiss A-1 Triad, Curtiss Jenny and Curtiss Robin. **Over 15,000 produced.** Initially, OX-5 as reliable as most engines, by the 1920s, less reliable than others.

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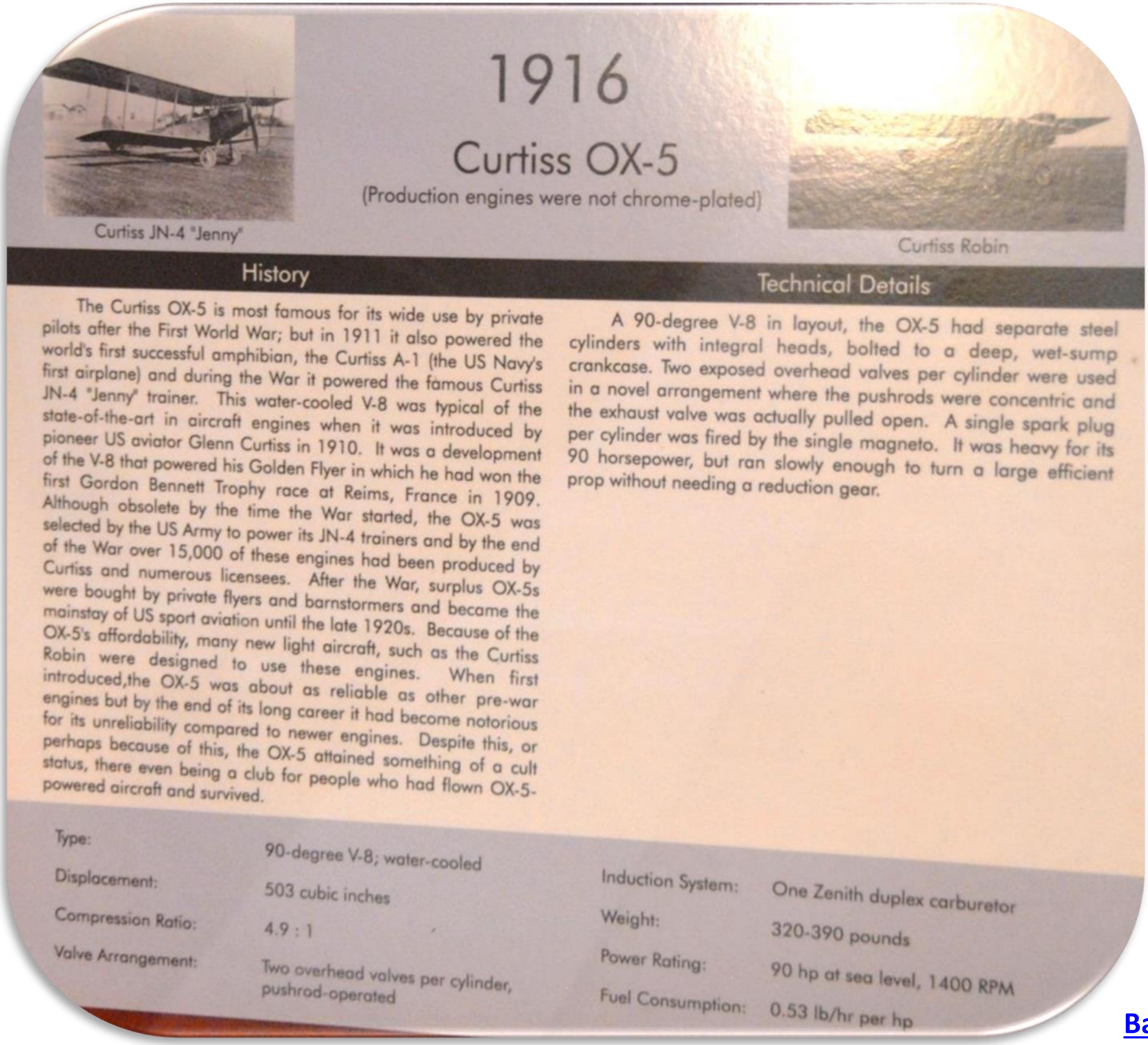

1916

Curtiss OX-5

(Production engines were not chrome-plated)

Curtiss JN-4 "Jenny"

Curtiss Robin

History

The Curtiss OX-5 is most famous for its wide use by private pilots after the First World War; but in 1911 it also powered the world's first successful amphibian, the Curtiss A-1 (the US Navy's first airplane) and during the War it powered the famous Curtiss JN-4 "Jenny" trainer. This water-cooled V-8 was typical of the state-of-the-art in aircraft engines when it was introduced by pioneer US aviator Glenn Curtiss in 1910. It was a development of the V-8 that powered his Golden Flyer in which he had won the first Gordon Bennett Trophy race at Reims, France in 1909. Although obsolete by the time the War started, the OX-5 was selected by the US Army to power its JN-4 trainers and by the end of the War over 15,000 of these engines had been produced by Curtiss and numerous licensees. After the War, surplus OX-5s were bought by private flyers and barnstormers and became the mainstay of US sport aviation until the late 1920s. Because of the OX-5's affordability, many new light aircraft, such as the Curtiss Robin were designed to use these engines. When first introduced,the OX-5 was about as reliable as other pre-war engines but by the end of its long career it had become notorious for its unreliability compared to newer engines. Despite this, or perhaps because of this, the OX-5 attained something of a cult status, there even being a club for people who had flown OX-5-powered aircraft and survived.

Technical Details

A 90-degree V-8 in layout, the OX-5 had separate steel cylinders with integral heads, bolted to a deep, wet-sump crankcase. Two exposed overhead valves per cylinder were used in a novel arrangement where the pushrods were concentric and the exhaust valve was actually pulled open. A single spark plug per cylinder was fired by the single magneto. It was heavy for its 90 horsepower, but ran slowly enough to turn a large efficient prop without needing a reduction gear.

Type:	90-degree V-8; water-cooled	Induction System:	One Zenith duplex carburetor
Displacement:	503 cubic inches	Weight:	320-390 pounds
Compression Ratio:	4.9 : 1	Power Rating:	90 hp at sea level, 1400 RPM
Valve Arrangement:	Two overhead valves per cylinder, pushrod-operated	Fuel Consumption:	0.53 lb/hr per hp

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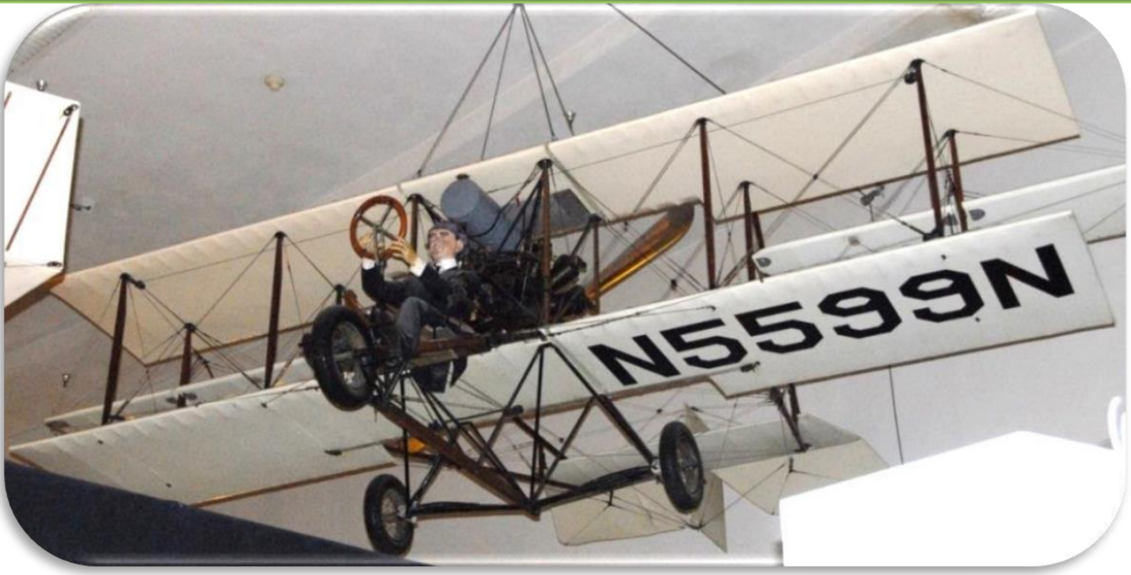

1st flight: 1914

Key Points: Beachey "Little Looper" (Reproduction). The Beachey-Eaton Biplane, "Little Looper," was built in Chicago in **1914**. Smaller and upgraded version Curtiss Model D Headless biplane, but **designed as an aerobatic biplane**. **80 horsepower**, 9 cylinder Le Rhône rotary engine. Achieved 84 mph, and **80 continuous inside loops**.

Extra Info: Lincoln J. Beachey (1887 – 1915), pioneer American aviator, learned to pilot aircraft at the Curtiss Flying School in Hammondsport, New York. Member of Glenn Curtiss' flying team in 1910. Acknowledged "**The World's Greatest Aviator**," of the time. Beachey was killed at the 1915 San Francisco Exposition when his aircraft wing spar broke during inverted flight, he survived the crash, but drowned in the bay. One of Beachey's mechanics was **Lawrence D. Bell**, later founder of Bell Aircraft.

This: A **flyable** reproduction built in 1948, by Albert Dudek (WWI barnstormer) Cleveland, Ohio. Donated to the Museum in 1979.

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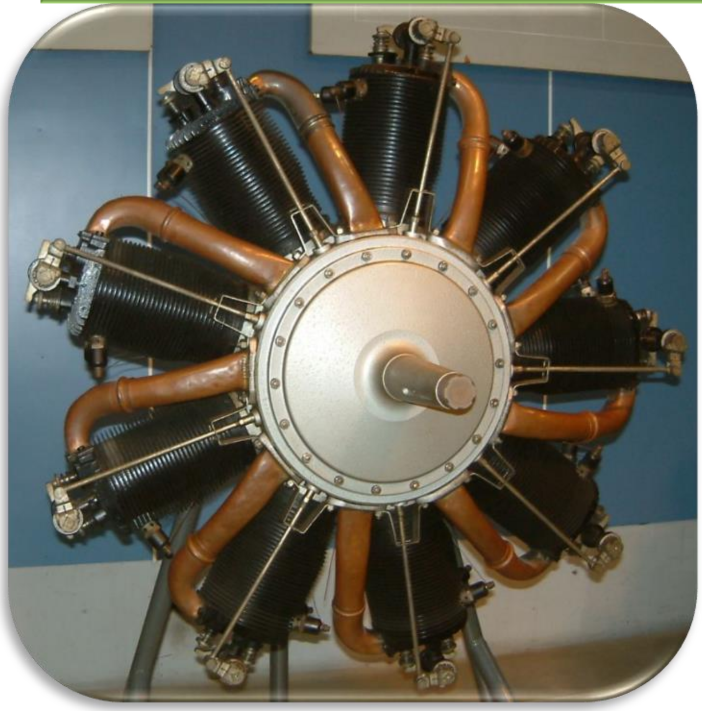

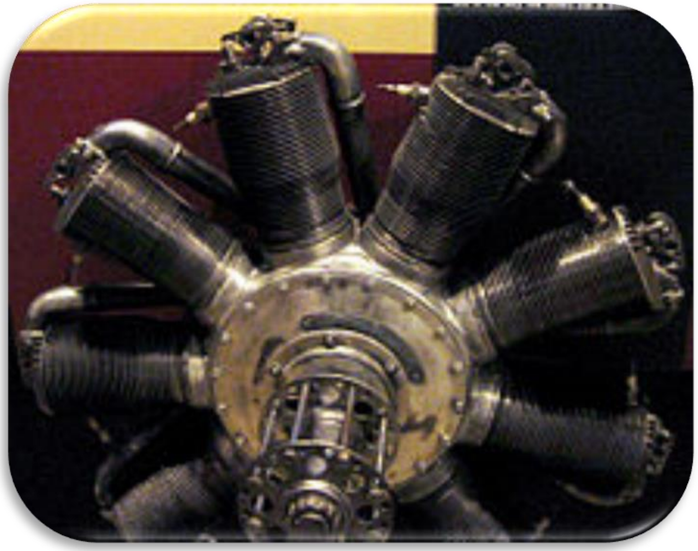

First run: 1910
(1088 built)

Key Points: Le Rhône (**Originals**) rotary aircraft engines produced in France by Société des Moteurs Le Rhône successor company of Gnome et Rhône. Not powerful (**largest 130 hp**), they were **dependable** rotary engines in 7 & 9 cylinder designs.

Extra Info:

- Copper induction tubes, 80 hp *forward,* 110 hp *behind* the cylinder's centerline.
- Two-way push-pull rod, single pivoting rocker arm moved both valves.
- Castor oil, a plant-derived lubricant , that the rotaries required, did not readily dissolve into the fuel and lubrication qualities were superior to mineral oils of the day.

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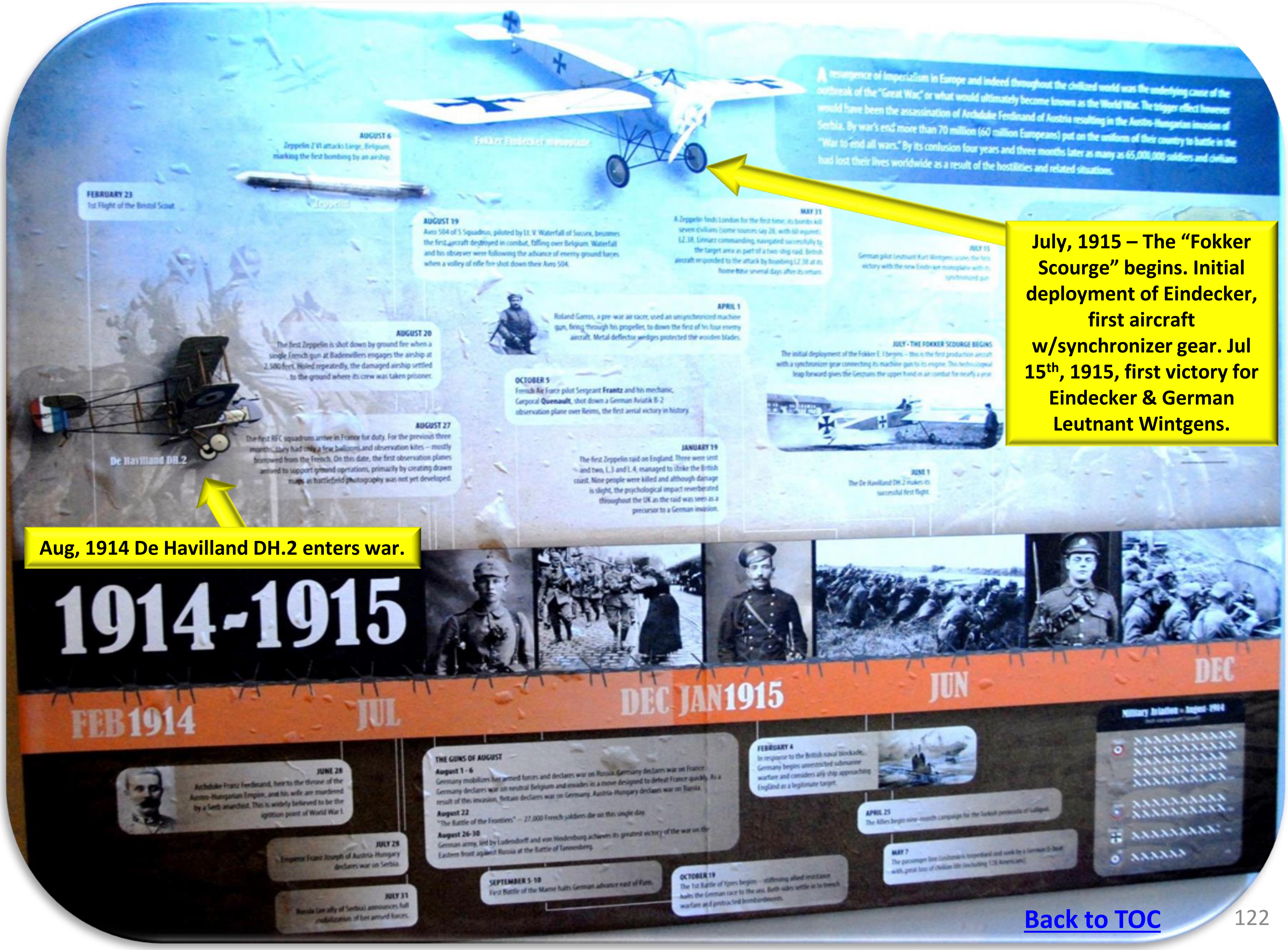

A resurgence of Imperialism in Europe and indeed throughout the civilized world was the underlying cause of the outbreak of the "Great War," or what would ultimately become known as the World War. The trigger effect however would have been the assassination of Archduke Ferdinand of Austria resulting in the Austro-Hungarian invasion of Serbia. By war's end more than 70 million (60 million Europeans) put on the uniform of their country to battle in the "War to end all wars." By its conlusion four years and three months later as many as 65,000,000 soldiers and civilians had lost their lives worldwide as a result of the hostilities and related situations.

FEBRUARY 23
1st Flight of the Bristol Scout

AUGUST 6
Zeppelin Z VI attacks Liege, Belgium, marking the first bombing by an airship.

AUGUST 19
Avro 504 of 5 Squadron, piloted by Lt. V. Waterfall of Sussex, becomes the first aircraft destroyed in combat, falling over Belgium. Waterfall and his observer were following the advance of enemy ground forces when a volley of rifle fire shot down their Avro 504.

AUGUST 20
The first Zeppelin is shot down by ground fire when a single French gun at Badenvillers engages the airship at 2,500 feet. Holed repeatedly, the damaged airship settled to the ground where its crew was taken prisoner.

AUGUST 27
The first RFC squadrons arrive in France for duty. For the previous three months, they had only a few balloons and observation kites – mostly borrowed from the French. On this date, the first observation planes arrived to support ground operations, primarily by creating drawn maps as battlefield photography was not yet developed.

OCTOBER 5
French Air Force pilot Sergeant **Frantz** and his mechanic, Corporal **Quenault**, shot down a German Aviatik B-2 observation plane over Reims, the first aerial victory in history.

JANUARY 19
The first Zeppelin raid on England. Three were sent and two, L.3 and L.4, managed to strike the British coast. Nine people were killed and although damage is slight, the psychological impact reverberated throughout the UK as the raid was seen as a precursor to a German invasion.

APRIL 1
Roland Garros, a pre-war air racer, used an unsynchronized machine gun, firing through his propeller, to down the first of his four enemy aircraft. Metal deflector wedges protected the wooden blades.

MAY 31
A Zeppelin finds London for the first time; its bombs kill seven civilians (some sources say 28, with 60 injured). LZ.38, Linnarz commanding, navigated successfully to the target area as part of a two-ship raid. British aircraft responded to the attack by bombing LZ.38 at its home base several days after its return.

JUNE 1
The De Havilland DH.2 makes its successful first flight.

JULY 15
German pilot Leutnant Kurt Wintgens scores the first victory with the new Eindecker monoplane with its synchronized gun.

JULY - THE FOKKER SCOURGE BEGINS
The initial deployment of the Fokker E. I begins – this is the first production aircraft with a synchronizer gear connecting its machine gun to its engine. This technological leap forward gives the Germans the upper hand in air combat for nearly a year.

1914-1915

FEB 1914 JUL DEC JAN 1915 JUN DEC

JUNE 28
Archduke Franz Ferdinand, heir to the throne of the Austro-Hungarian Empire, and his wife are murdered by a Serb anarchist. This is widely believed to be the ignition point of World War I.

JULY 28
Emperor Franz Joseph of Austria-Hungary declares war on Serbia.

JULY 31
Russia (an ally of Serbia) announces full mobilization of her armed forces.

THE GUNS OF AUGUST

August 1 - 6
Germany mobilizes her armed forces and declares war on Russia. Germany declares war on France. Germany declares war on neutral Belgium and invades in a move designed to defeat France quickly. As a result of this invasion, Britain declares war on Germany. Austria-Hungary declares war on Russia.

August 22
"The Battle of the Frontiers" – 27,000 French soldiers die on this single day.

August 26-30
German army, led by Ludendorff and von Hindenburg achieves its greatest victory of the war on the Eastern front against Russia at the Battle of Tannenberg.

SEPTEMBER 5-10
First Battle of the Marne halts German advance east of Paris.

OCTOBER 19
The 1st Battle of Ypres begins – stiffening allied resistance halts the German race to the sea. Both sides settle in to trench warfare and protracted bombardments.

FEBRUARY 4
In response to the British naval blockade, Germany begins unrestricted submarine warfare and considers any ship approaching England as a legitimate target.

APRIL 25
The Allies begin nine-month campaign for the Turkish peninsula of Gallipoli.

MAY 7
The passenger liner Lusitania is torpedoed and sunk by a German U-boat with great loss of civilian life (including 128 Americans).

July, 1915 – The "Fokker Scourge" begins. Initial deployment of Eindecker, first aircraft w/synchronizer gear. Jul 15th, 1915, first victory for Eindecker & German Leutnant Wintgens.

Aug, 1914 De Havilland DH.2 enters war.

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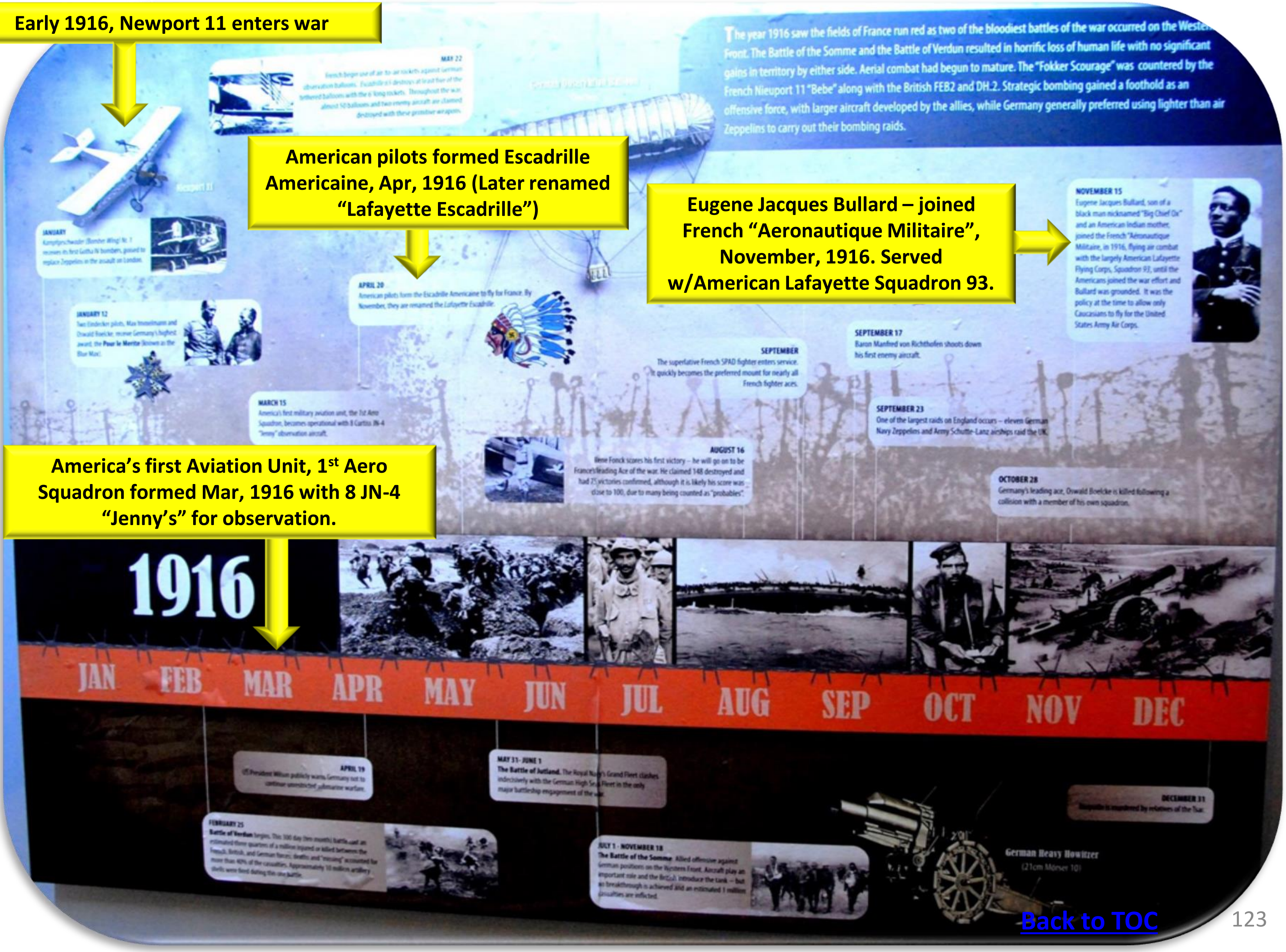
Early 1916, Newport 11 enters war

American pilots formed Escadrille Americaine, Apr, 1916 (Later renamed "Lafayette Escadrille")

Eugene Jacques Bullard – joined French "Aeronautique Militaire", November, 1916. Served w/American Lafayette Squadron 93.

America's first Aviation Unit, 1st Aero Squadron formed Mar, 1916 with 8 JN-4 "Jenny's" for observation.



The year 1916 saw the fields of France run red as two of the bloodiest battles of the war occurred on the Western Front. The Battle of the Somme and the Battle of Verdun resulted in horrific loss of human life with no significant gains in territory by either side. Aerial combat had begun to mature. The "Fokker Scourage" was countered by the French Nieuport 11 "Bebe" along with the British FEB2 and DH.2. Strategic bombing gained a foothold as an offensive force, with larger aircraft developed by the allies, while Germany generally preferred using lighter than air Zeppelins to carry out their bombing raids.

JANUARY
Kampfgeschwader (Bomber Wing) Nr. 1 receives its first Gotha IV bombers, poised to replace Zeppelins in the assault on London.

JANUARY 12
Two Eindecker pilots, Max Immelmann and Oswald Boelcke, receive Germany's highest award, the **Pour le Merite** (known as the Blue Max).

MARCH 15
America's first military aviation unit, the 1st Aero Squadron, becomes operational with 8 Curtiss JN-4 "Jenny" observation aircraft.

APRIL 20
American pilots form the Escadrille Americaine to fly for France. By November, they are renamed the *Lafayette Escadrille*.

MAY 22
French begin use of air to air rockets against German observation balloons. Escadrille 65 destroys at least five of the tethered balloons with the 6' long rockets. Throughout the war, almost 50 balloons and two enemy aircraft are claimed destroyed with these primitive weapons.

AUGUST 16
Rene Fonck scores his first victory – he will go on to be France's leading Ace of the war. He claimed 148 destroyed and had 75 victories confirmed, although it is likely his score was close to 100, due to many being counted as "probables".

SEPTEMBER
The superlative French SPAD fighter enters service. It quickly becomes the preferred mount for nearly all French fighter aces.

SEPTEMBER 17
Baron Manfred von Richthofen shoots down his first enemy aircraft.

SEPTEMBER 23
One of the largest raids on England occurs – eleven German Navy Zeppelins and Army Schutte-Lanz airships raid the UK.

OCTOBER 28
Germany's leading ace, Oswald Boelcke is killed following a collision with a member of his own squadron.

NOVEMBER 15
Eugene Jacques Bullard, son of a black man nicknamed "Big Chief Ox" and an American Indian mother, joined the French "Aéronautique Militaire, in 1916, flying air combat with the largely American Lafayette Flying Corps, Squadron 93, until the Americans joined the war effort and Bullard was grounded. It was the policy at the time to allow only Caucasians to fly for the United States Army Air Corps.

FEBRUARY 25
Battle of Verdun begins. This 300 day (ten month) battle saw an estimated three quarters of a million injured or killed between the French, British, and German forces; deaths and "missing" accounted for more than 40% of the casualties. Approximately 10 million artillery shells were fired during this one battle.

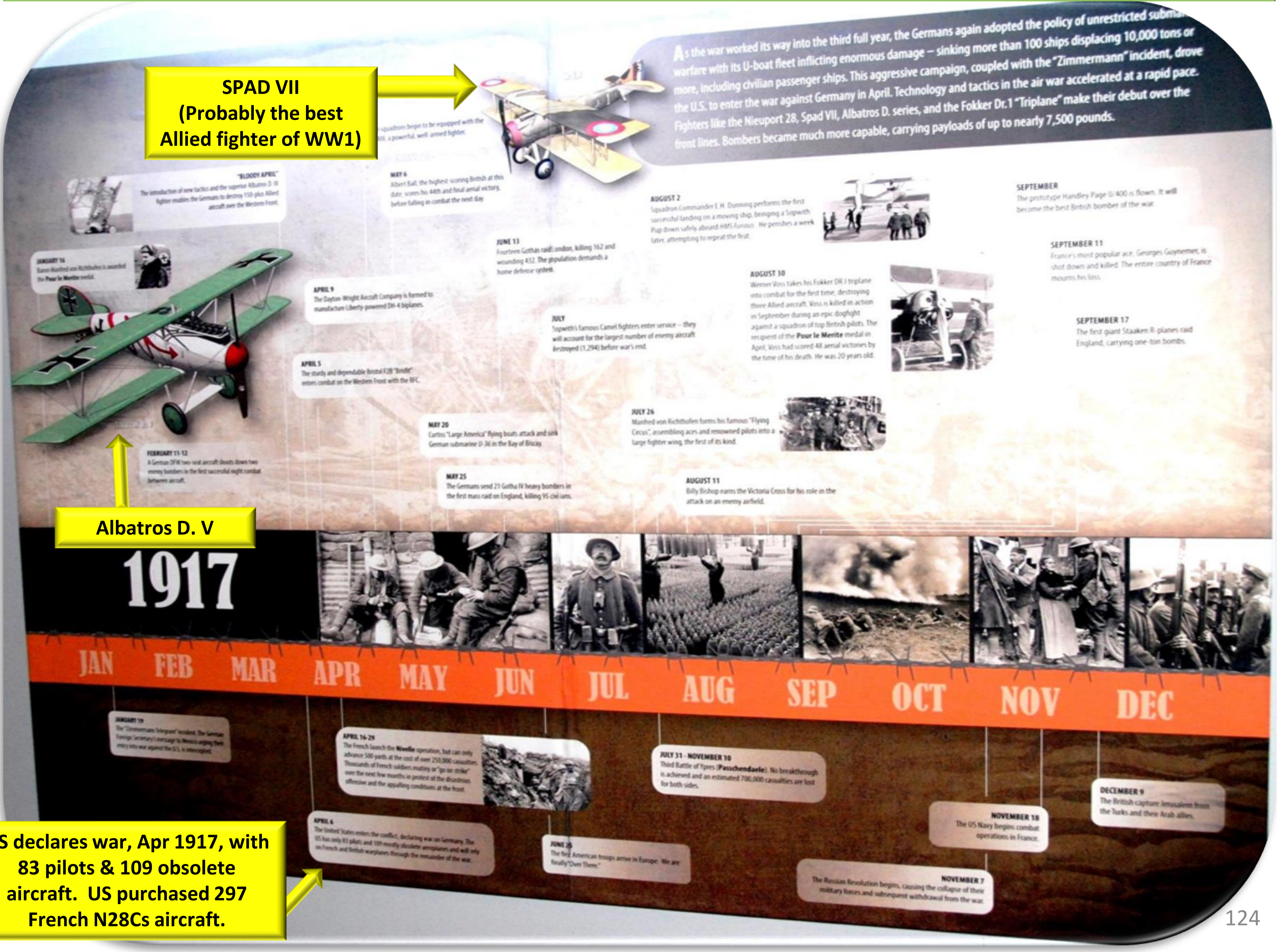
APRIL 19
US President Wilson publicly warns Germany not to continue unrestricted submarine warfare.

MAY 31 - JUNE 1
The Battle of Jutland. The Royal Navy's Grand Fleet clashes indecisively with the German High Seas Fleet in the only major battleship engagement of the war.

JULY 1 - NOVEMBER 18
The Battle of the Somme. Allied offensive against German positions on the Western Front. Aircraft play an important role and the British introduce the tank – but no breakthrough is achieved and an estimated 1 million casualties are inflicted.

DECEMBER 31
Rasputin is murdered by relatives of the Tsar.

World War I Gallery



SPAD VII
(Probably the best Allied fighter of WW1)

As the war worked its way into the third full year, the Germans again adopted the policy of unrestricted submarine warfare with its U-boat fleet inflicting enormous damage – sinking more than 100 ships displacing 10,000 tons or more, including civilian passenger ships. This aggressive campaign, coupled with the "Zimmermann" incident, drove the U.S. to enter the war against Germany in April. Technology and tactics in the air war accelerated at a rapid pace. Fighters like the Nieuport 28, Spad VII, Albatros D. series, and the Fokker Dr.1 "Triplane" make their debut over the front lines. Bombers became much more capable, carrying payloads of up to nearly 7,500 pounds.

squadrons begin to be equipped with the
a powerful, well-armed fighter.

"BLOODY APRIL"
The introduction of new tactics and the superior Albatros D. III fighter enables the Germans to destroy 150-plus Allied aircraft over the Western Front.

JANUARY 16
Baron Manfred von Richthofen is awarded the **Pour le Merite** medal.

FEBRUARY 11-12
A German DFW two-seat aircraft shoots down two enemy bombers in the first successful night combat between aircraft.

APRIL 9
The Dayton-Wright Aircraft Company is formed to manufacture Liberty-powered DH-4 biplanes.

APRIL 5
The sturdy and dependable Bristol F2B "Bristle" enters combat on the Western Front with the RFC.

MAY 6
Albert Ball, the highest-scoring British at this date, scores his 44th and final aerial victory, before falling in combat the next day.

MAY 20
Curtiss "Large America" flying boats attack and sink German submarine U-36 in the Bay of Biscay.

MAY 25
The Germans send 21 Gotha IV heavy bombers in the first mass raid on England, killing 95 civilians.

JUNE 13
Fourteen Gothas raid London, killing 162 and wounding 432. The population demands a home defense system.

JULY
Sopwith's famous Camel fighters enter service – they will account for the largest number of enemy aircraft destroyed (1,294) before war's end.

JULY 26
Manfred von Richthofen forms his famous "Flying Circus", assembling aces and renowned pilots into a large fighter wing, the first of its kind.

AUGUST 2
Squadron Commander E. H. Dunning performs the first successful landing on a moving ship, bringing a Sopwith Pup down safely aboard HMS Furious. He perishes a week later, attempting to repeat the feat.

AUGUST 11
Billy Bishop earns the Victoria Cross for his role in the attack on an enemy airfield.

AUGUST 30
Werner Voss takes his Fokker DR.I triplane into combat for the first time, destroying three Allied aircraft. Voss is killed in action in September during an epic dogfight against a squadron of top British pilots. The recipient of the **Pour le Merite** medal in April, Voss had scored 48 aerial victories by the time of his death. He was 20 years old.

SEPTEMBER
The prototype Handley Page O/400 is flown. It will become the best British bomber of the war.

SEPTEMBER 11
France's most popular ace, Georges Guynemer, is shot down and killed. The entire country of France mourns his loss.

SEPTEMBER 17
The first giant Staaken R-planes raid England, carrying one-ton bombs.

Albatros D. V

1917

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

JANUARY 19
The "Zimmermann Telegram" incident. The German Foreign Secretary's message to Mexico urging their entry into war against the U.S. is intercepted.

APRIL 16-29
The French launch the **Nivelle** operation, but can only advance 500 yards at the cost of over 250,000 casualties. Thousands of French soldiers mutiny or "go on strike" over the next few months in protest of the disastrous offensive and the appalling conditions at the front.

APRIL 6
The United States enters the conflict, declaring war on Germany. The US has only 83 pilots and 109 mostly obsolete aeroplanes and will rely on French and British warplanes through the remainder of the war.

JUNE 25
The first American troops arrive in Europe. We are finally "Over There."

JULY 31 - NOVEMBER 10
Third Battle of Ypres (**Passchendaele**). No breakthrough is achieved and an estimated 700,000 casualties are lost for both sides.

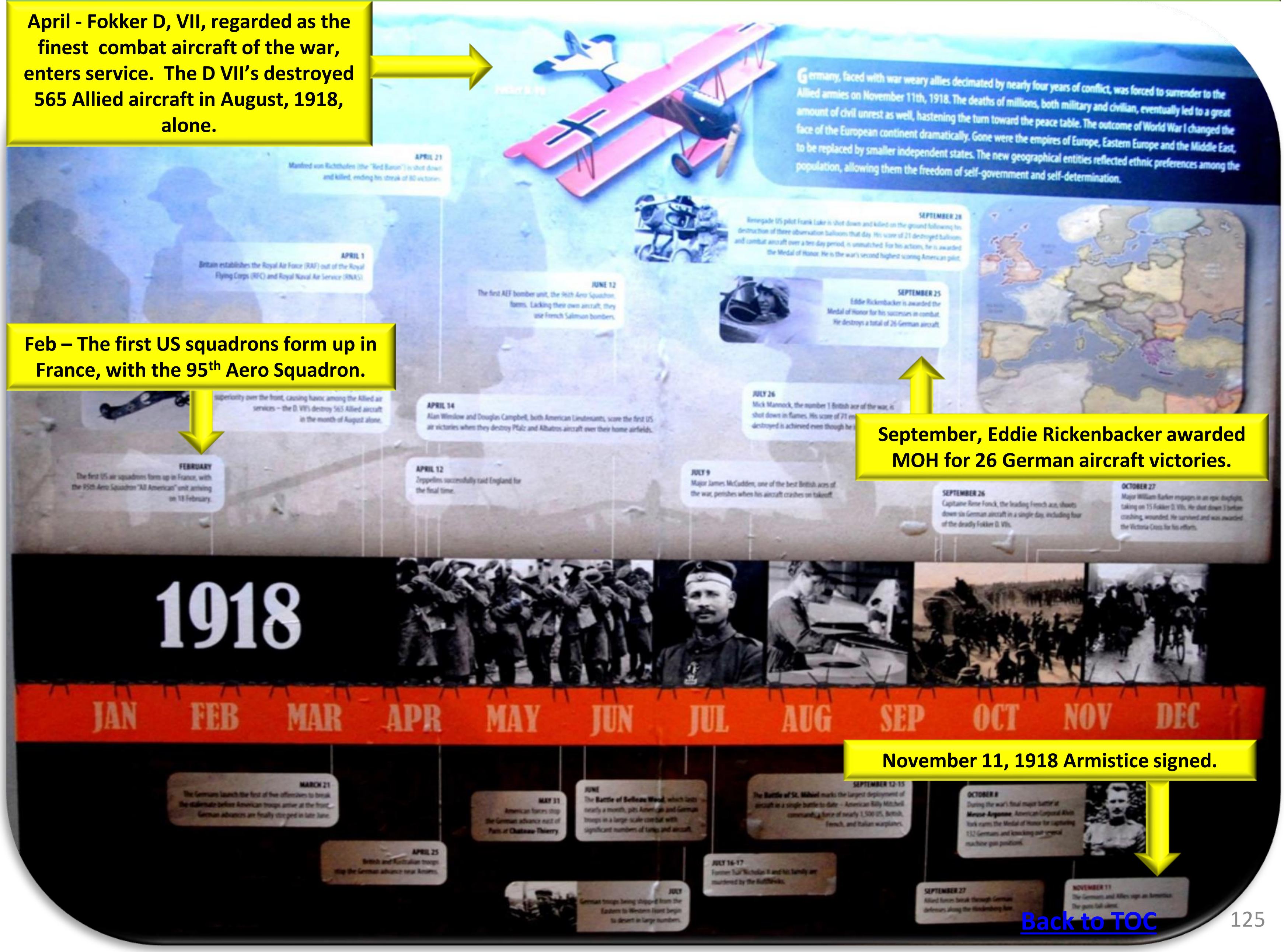
NOVEMBER 7
The Russian Revolution begins, causing the collapse of their military forces and subsequent withdrawal from the war.

NOVEMBER 18
The US Navy begins combat operations in France.

DECEMBER 9
The British capture Jerusalem from the Turks and their Arab allies.

US declares war, Apr 1917, with 83 pilots & 109 obsolete aircraft. US purchased 297 French N28Cs aircraft.

World War I Gallery


Germany, faced with war weary allies decimated by nearly four years of conflict, was forced to surrender to the Allied armies on November 11th, 1918. The deaths of millions, both military and civilian, eventually led to a great amount of civil unrest as well, hastening the turn toward the peace table. The outcome of World War I changed the face of the European continent dramatically. Gone were the empires of Europe, Eastern Europe and the Middle East, to be replaced by smaller independent states. The new geographical entities reflected ethnic preferences among the population, allowing them the freedom of self-government and self-determination.
APRIL 21
APRIL 1
JUNE 12
SEPTEMBER 28
SEPTEMBER 25
Eddie Rickenbacker is awarded the Medal of Honor for his successes in combat. He destroys a total of 26 German aircraft.
FEBRUARY
The first US air squadrons form up in France, with the 95th Aero Squadron "All American" unit arriving on 18 February.
APRIL 14
APRIL 12
Zeppelins successfully raid England for the final time.
JULY 26
JULY 9
SEPTEMBER 26
OCTOBER 27
1918
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MARCH 21
APRIL 25
MAY 31
JUNE
JULY
JULY 16-17
SEPTEMBER 12-15
OCTOBER 8
SEPTEMBER 27
NOVEMBER 11

April - Fokker D, VII, regarded as the finest combat aircraft of the war, enters service. The D VII's destroyed 565 Allied aircraft in August, 1918, alone.

Feb – The first US squadrons form up in France, with the 95th Aero Squadron.

September, Eddie Rickenbacker awarded MOH for 26 German aircraft victories.

November 11, 1918 Armistice signed.

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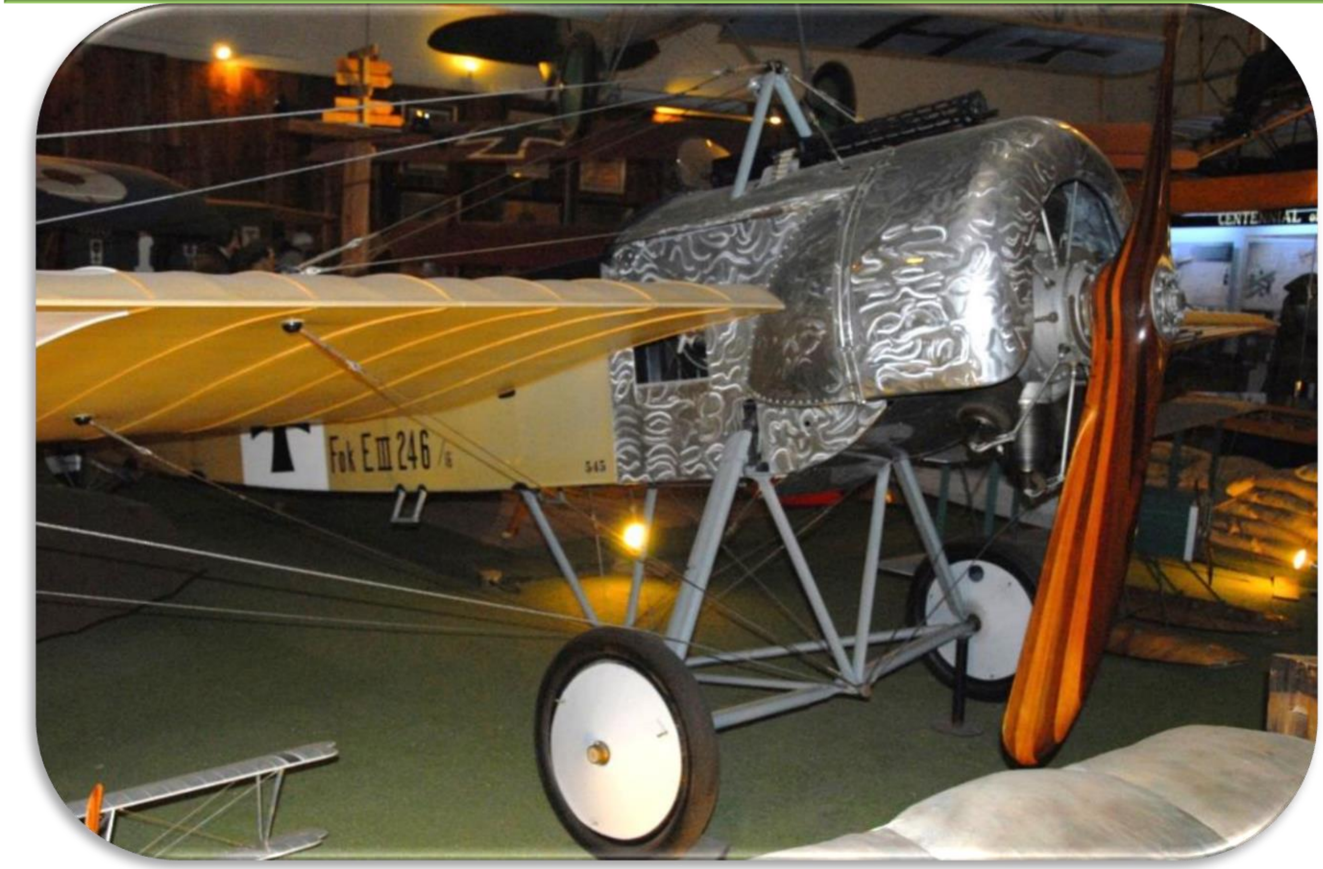

1st flight: 1915
(At least 110 built)

Key Points: **Fokker E-III Eindecker** (Reproduction). German monoplane single-seat by Anthony Fokker. Developed in **April 1915**. **First German fighter aircraft fitted with a synchronizer gear**. Known as the **"Fokker Scourge",** 594 built. Fokker nearly invincible, until the spring of 1916, when the French Nieuport II and the British DH-2 entered service.

This: A **flyable** reproduction built by **Museum volunteers** led by **Bob Greenaway**, completed in five years and presented on August 26, 1997.

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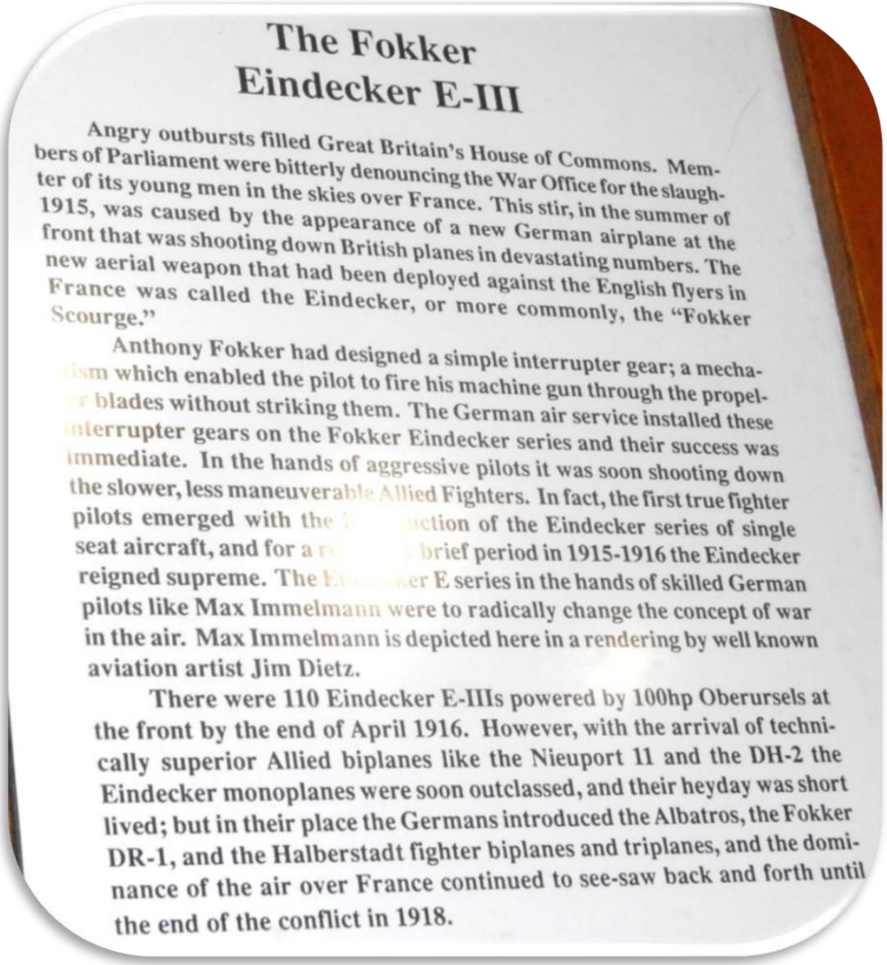
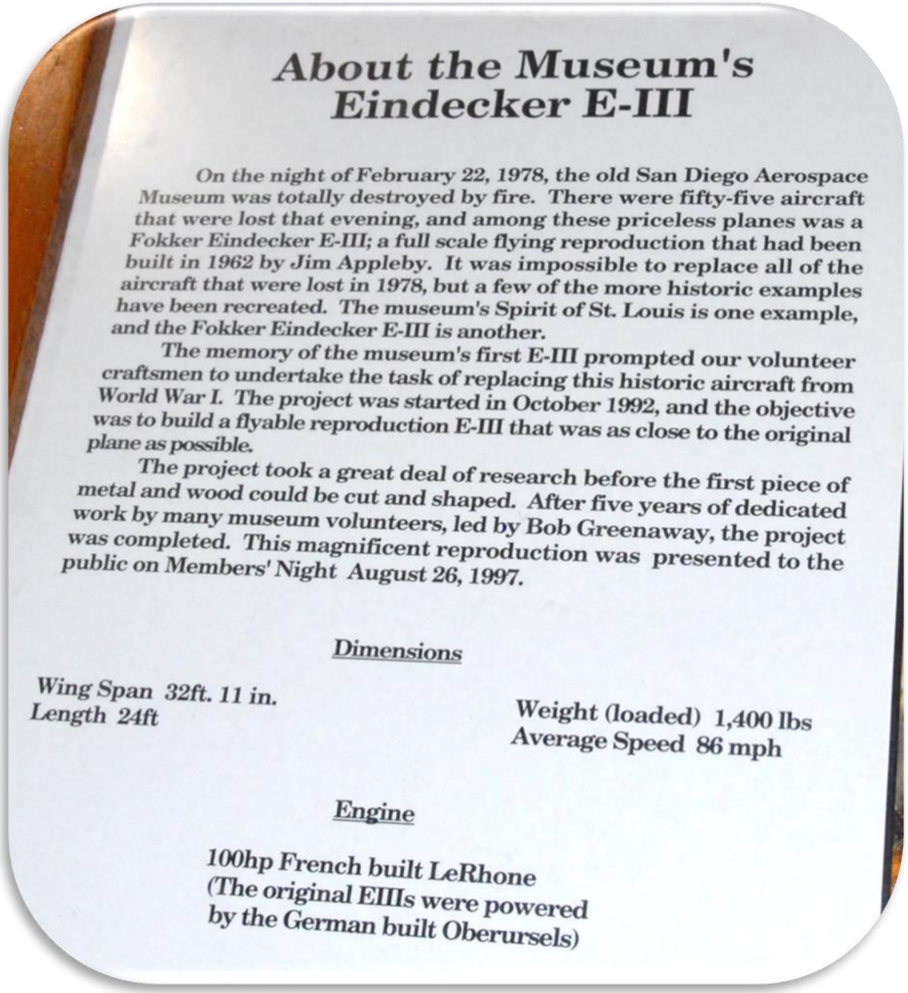


The Fokker Eindecker E-III

Angry outbursts filled Great Britain's House of Commons. Members of Parliament were bitterly denouncing the War Office for the slaughter of its young men in the skies over France. This stir, in the summer of 1915, was caused by the appearance of a new German airplane at the front that was shooting down British planes in devastating numbers. The new aerial weapon that had been deployed against the English flyers in France was called the Eindecker, or more commonly, the "Fokker Scourge."

Anthony Fokker had designed a simple interrupter gear; a mechanism which enabled the pilot to fire his machine gun through the propeller blades without striking them. The German air service installed these interrupter gears on the Fokker Eindecker series and their success was immediate. In the hands of aggressive pilots it was soon shooting down the slower, less maneuverable Allied Fighters. In fact, the first true fighter pilots emerged with the introduction of the Eindecker series of single seat aircraft, and for a relatively brief period in 1915-1916 the Eindecker reigned supreme. The Eindecker E series in the hands of skilled German pilots like Max Immelmann were to radically change the concept of war in the air. Max Immelmann is depicted here in a rendering by well known aviation artist Jim Dietz.

There were 110 Eindecker E-IIIs powered by 100hp Oberursels at the front by the end of April 1916. However, with the arrival of technically superior Allied biplanes like the Nieuport 11 and the DH-2 the Eindecker monoplanes were soon outclassed, and their heyday was short lived; but in their place the Germans introduced the Albatros, the Fokker DR-1, and the Halberstadt fighter biplanes and triplanes, and the dominance of the air over France continued to see-saw back and forth until the end of the conflict in 1918.



About the Museum's Eindecker E-III

On the night of February 22, 1978, the old San Diego Aerospace Museum was totally destroyed by fire. There were fifty-five aircraft that were lost that evening, and among these priceless planes was a Fokker Eindecker E-III; a full scale flying reproduction that had been built in 1962 by Jim Appleby. It was impossible to replace all of the aircraft that were lost in 1978, but a few of the more historic examples have been recreated. The museum's Spirit of St. Louis is one example, and the Fokker Eindecker E-III is another.

The memory of the museum's first E-III prompted our volunteer craftsmen to undertake the task of replacing this historic aircraft from World War I. The project was started in October 1992, and the objective was to build a flyable reproduction E-III that was as close to the original plane as possible.

The project took a great deal of research before the first piece of metal and wood could be cut and shaped. After five years of dedicated work by many museum volunteers, led by Bob Greenaway, the project was completed. This magnificent reproduction was presented to the public on Members' Night August 26, 1997.

Dimensions

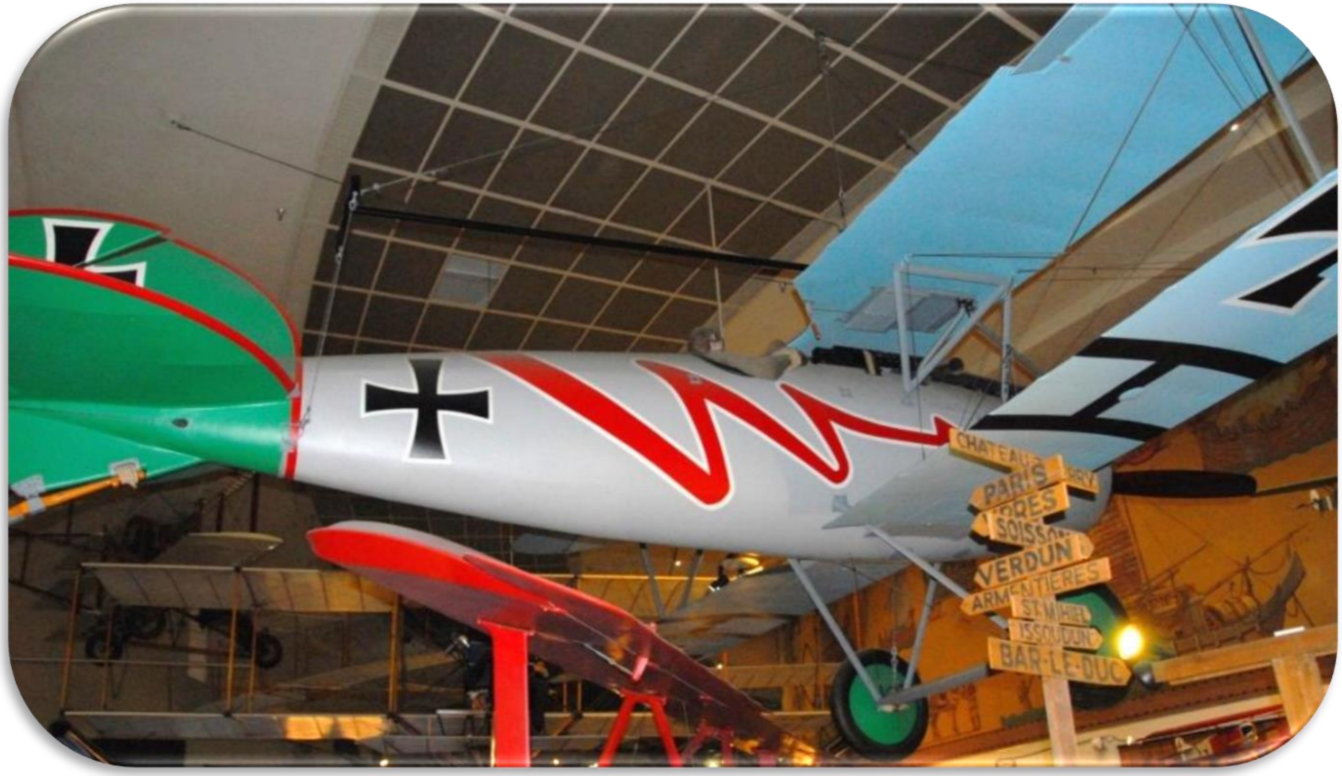
Wing Span 32ft. 11 in.
Length 24ft

Weight (loaded) 1,400 lbs
Average Speed 86 mph

Engine

100hp French built LeRhone
(The original EIIIs were powered
by the German built Oberursels)

World War I Gallery


PARIS
YPRES
SOISSONS
VERDUN
ARMENTIERES
ST MIHIEL
ISSOUDUN
BAR-LE-DUC

1st flight: 1916
(2500+ V/Va built)

Key Points: **Albatros D. Va** (Reproduction) **Primary German fighter. “**D. I” model in 1916; “D. V” and “D. Va” in 1917. **Over 2,500 D. V/Va’s built. Approx. 50% of all German fighters were Albatros’.** Manfred von **Richthofen, made 60 of 80 kills in the Albatros**.
This: A **flyable** reproduction built by **Jim and Zona Appleby** of Antique Aero, Ltd., Riverside, CA. Markings of German Jasta (squadron), “**Flying Circus**”, called the “**The Green Tails**.” Red lightning bolt was von Hippel’s marking. Only two original Albatros in world, Australian War Museum & Smithsonian. Powered by a rare 1917, 212 hp Hall-Scott L-6 engine.

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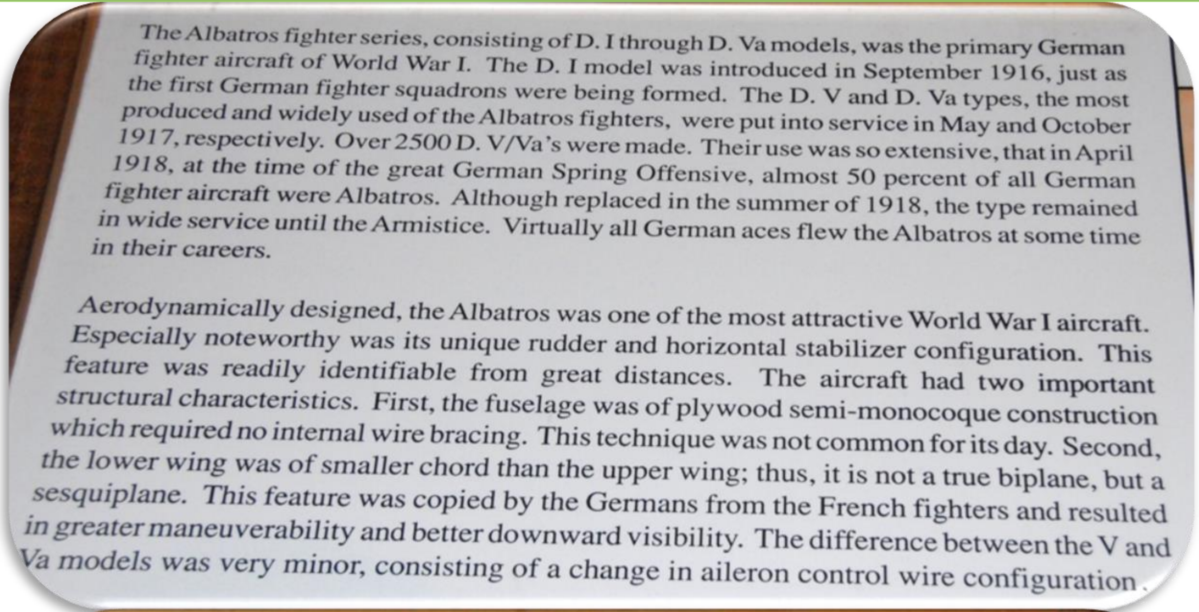
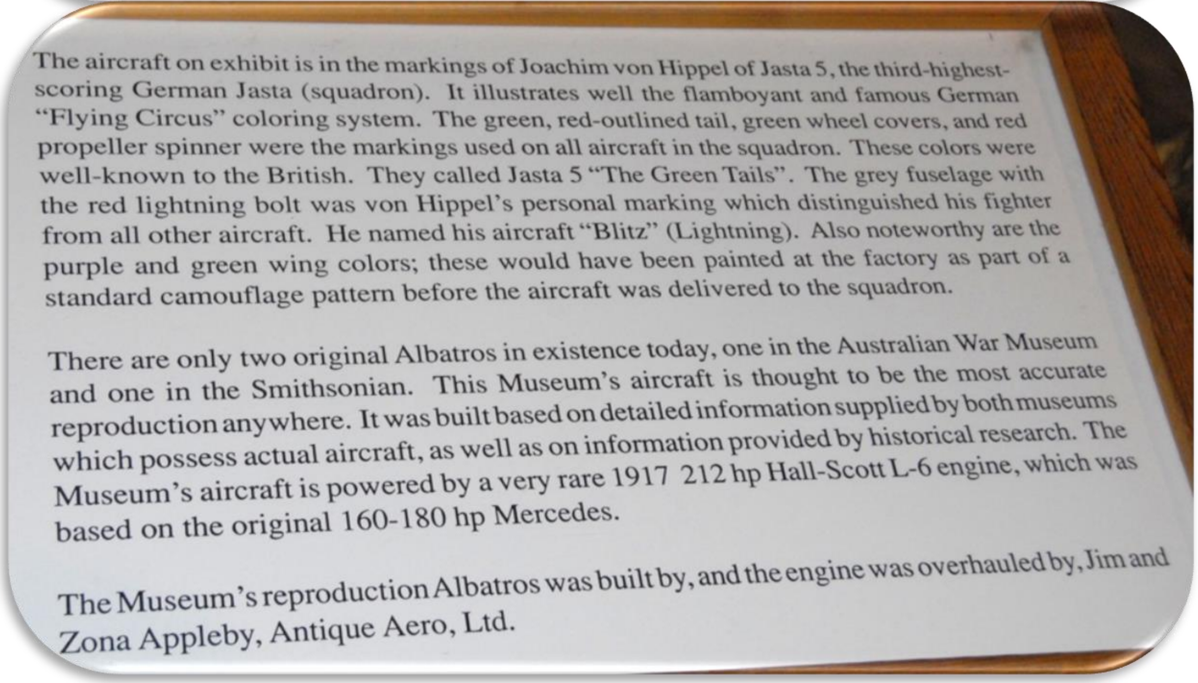
World War I Gallery



The Albatros fighter series, consisting of D. I through D. Va models, was the primary German fighter aircraft of World War I. The D. I model was introduced in September 1916, just as the first German fighter squadrons were being formed. The D. V and D. Va types, the most produced and widely used of the Albatros fighters, were put into service in May and October 1917, respectively. Over 2500 D. V/Va's were made. Their use was so extensive, that in April 1918, at the time of the great German Spring Offensive, almost 50 percent of all German fighter aircraft were Albatros. Although replaced in the summer of 1918, the type remained in wide service until the Armistice. Virtually all German aces flew the Albatros at some time in their careers.

Aerodynamically designed, the Albatros was one of the most attractive World War I aircraft. Especially noteworthy was its unique rudder and horizontal stabilizer configuration. This feature was readily identifiable from great distances. The aircraft had two important structural characteristics. First, the fuselage was of plywood semi-monocoque construction which required no internal wire bracing. This technique was not common for its day. Second, the lower wing was of smaller chord than the upper wing; thus, it is not a true biplane, but a sesquiplane. This feature was copied by the Germans from the French fighters and resulted in greater maneuverability and better downward visibility. The difference between the V and Va models was very minor, consisting of a change in aileron control wire configuration.



The aircraft on exhibit is in the markings of Joachim von Hippel of Jasta 5, the third-highest-scoring German Jasta (squadron). It illustrates well the flamboyant and famous German "Flying Circus" coloring system. The green, red-outlined tail, green wheel covers, and red propeller spinner were the markings used on all aircraft in the squadron. These colors were well-known to the British. They called Jasta 5 "The Green Tails". The grey fuselage with the red lightning bolt was von Hippel's personal marking which distinguished his fighter from all other aircraft. He named his aircraft "Blitz" (Lightning). Also noteworthy are the purple and green wing colors; these would have been painted at the factory as part of a standard camouflage pattern before the aircraft was delivered to the squadron.

There are only two original Albatros in existence today, one in the Australian War Museum and one in the Smithsonian. This Museum's aircraft is thought to be the most accurate reproduction anywhere. It was built based on detailed information supplied by both museums which possess actual aircraft, as well as on information provided by historical research. The Museum's aircraft is powered by a very rare 1917 212 hp Hall-Scott L-6 engine, which was based on the original 160-180 hp Mercedes.

The Museum's reproduction Albatros was built by, and the engine was overhauled by, Jim and Zona Appleby, Antique Aero, Ltd.

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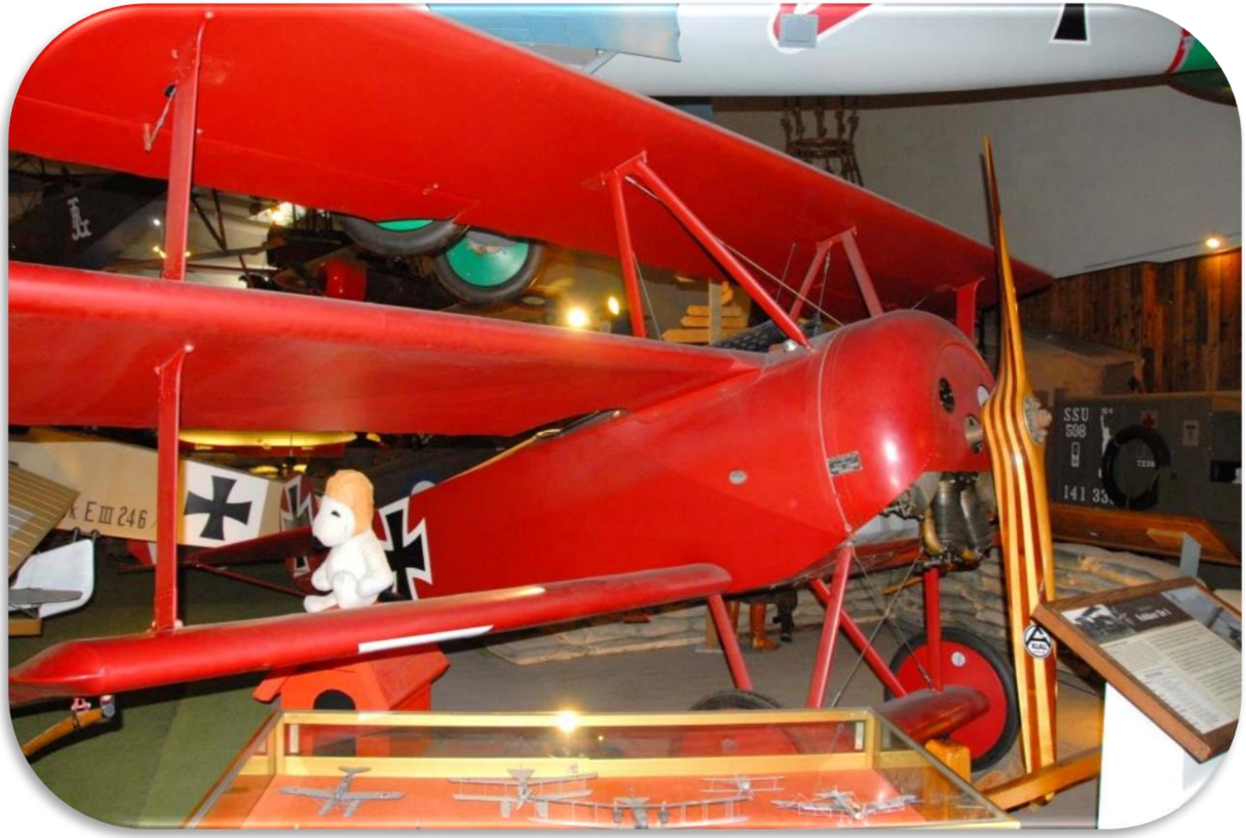

1st flight: 1917
(320 built)

Key Points: **Fokker Dr. I** (Reproduction) A **famous aircraft in aviation history**. Associated with the **"Red Baron," Manfred von Richthofen**. Flown by practically all of Germany's top aces in 1917 to 1918. **Only 320 built**, flew on the Western Front for **only about 8 months**. Problems: **collapse of the top wing**, very **slow** compared to its counterparts, but **extremely maneuverable**. Manfred von Richthofen, **20 of his 80 kills** in the Fokker Dr. I.
This: Is a **flyable** reproduction built by Jim Appleby and Dan San Abbott in 1989. The engine is an **original Le Rhone engine**.

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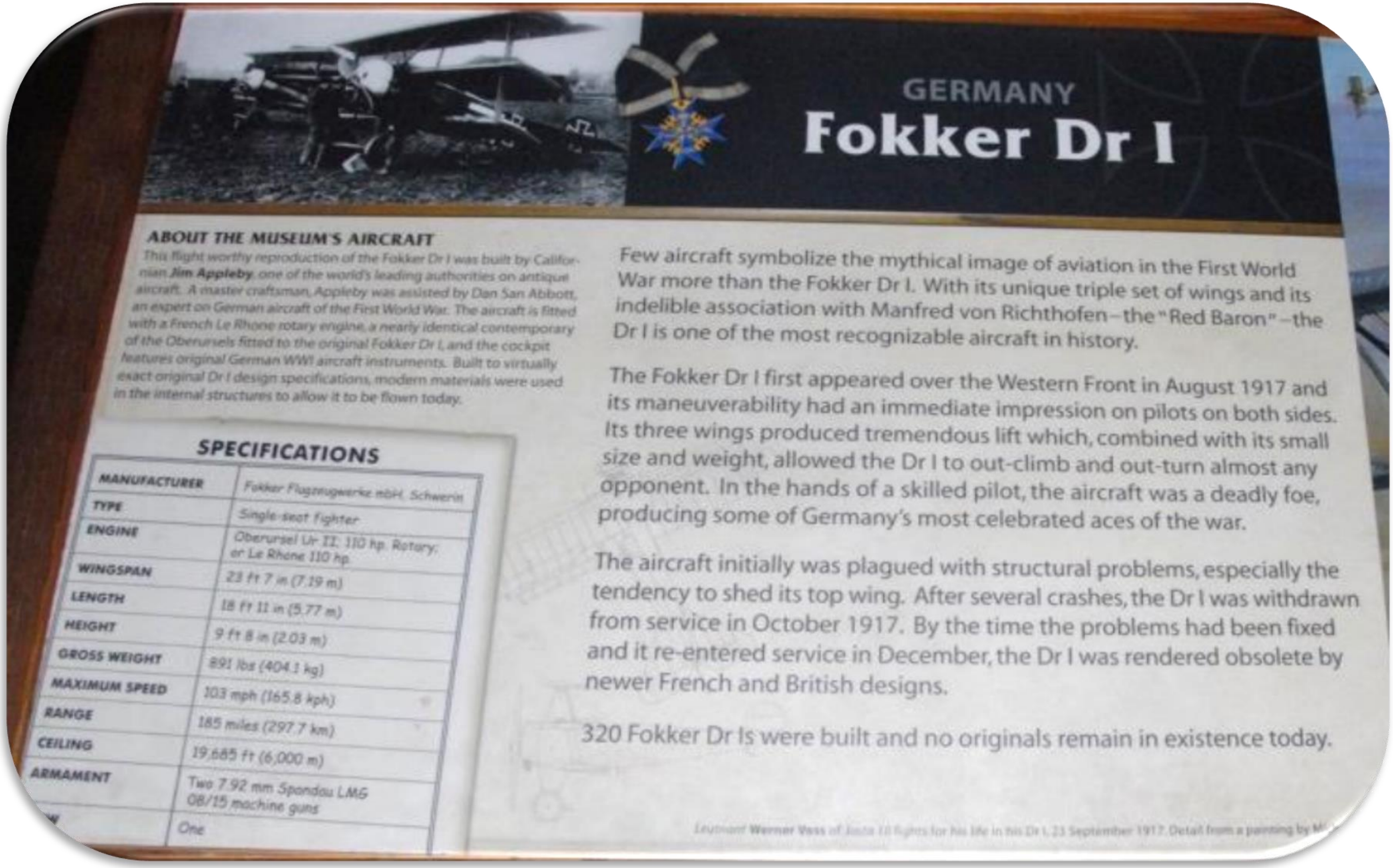

GERMANY

Fokker Dr I

ABOUT THE MUSEUM'S AIRCRAFT

This flight worthy reproduction of the Fokker Dr I was built by Californian ***Jim Appleby****, one of the world's leading authorities on antique aircraft. A master craftsman, Appleby was assisted by Dan San Abbott, an expert on German aircraft of the First World War. The aircraft is fitted with a French Le Rhone rotary engine, a nearly identical contemporary of the Oberursels fitted to the original Fokker Dr I, and the cockpit features original German WWI aircraft instruments. Built to virtually exact original Dr I design specifications, modern materials were used in the internal structures to allow it to be flown today.*

SPECIFICATIONS

MANUFACTURER	Fokker Flugzeugwerke mbH, Schwerin
TYPE	Single-seat fighter
ENGINE	Oberursel Ur II; 110 hp. Rotary; or Le Rhone 110 hp.
WINGSPAN	23 ft 7 in (7.19 m)
LENGTH	18 ft 11 in (5.77 m)
HEIGHT	9 ft 8 in (2.03 m)
GROSS WEIGHT	891 lbs (404.1 kg)
MAXIMUM SPEED	103 mph (165.8 kph)
RANGE	185 miles (297.7 km)
CEILING	19,685 ft (6,000 m)
ARMAMENT	Two 7.92 mm Spandau LMG 08/15 machine guns
W	One

Few aircraft symbolize the mythical image of aviation in the First World War more than the Fokker Dr I. With its unique triple set of wings and its indelible association with Manfred von Richthofen – the "Red Baron" – the Dr I is one of the most recognizable aircraft in history.

The Fokker Dr I first appeared over the Western Front in August 1917 and its maneuverability had an immediate impression on pilots on both sides. Its three wings produced tremendous lift which, combined with its small size and weight, allowed the Dr I to out-climb and out-turn almost any opponent. In the hands of a skilled pilot, the aircraft was a deadly foe, producing some of Germany's most celebrated aces of the war.

The aircraft initially was plagued with structural problems, especially the tendency to shed its top wing. After several crashes, the Dr I was withdrawn from service in October 1917. By the time the problems had been fixed and it re-entered service in December, the Dr I was rendered obsolete by newer French and British designs.

320 Fokker Dr Is were built and no originals remain in existence today.

Leutnant **Werner Voss** *of Jasta 10 fights for his life in his Dr I, 23 September 1917. Detail from a painting by M*

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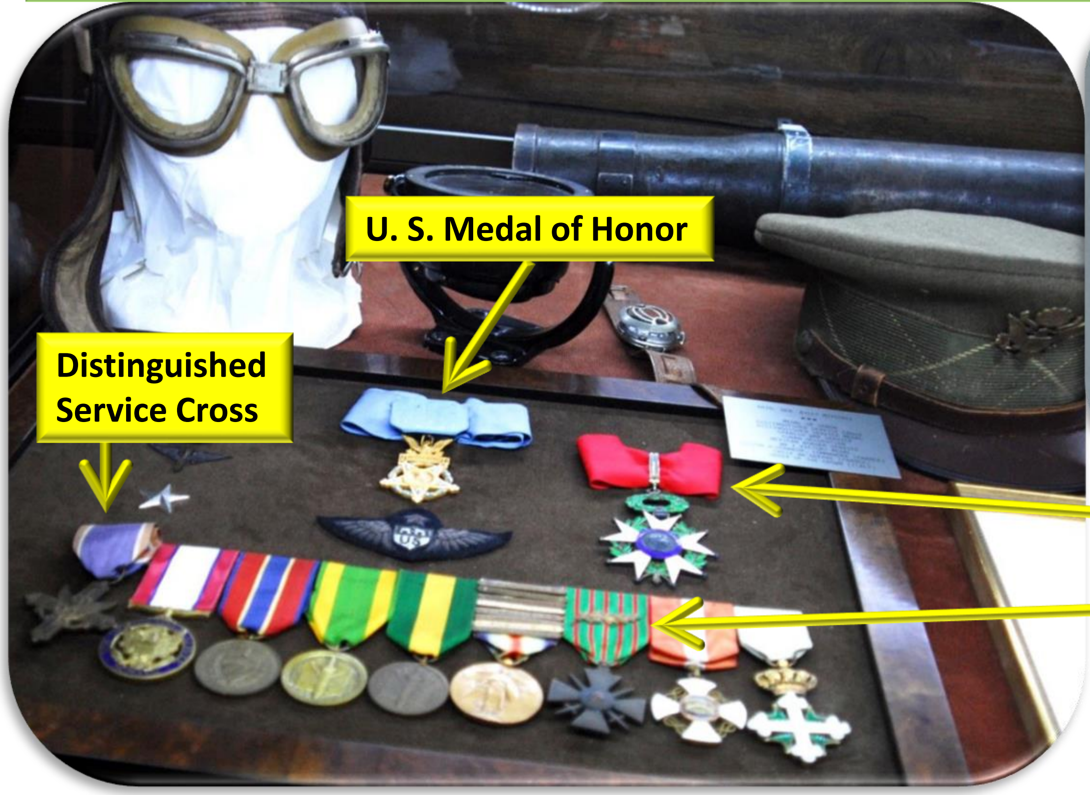

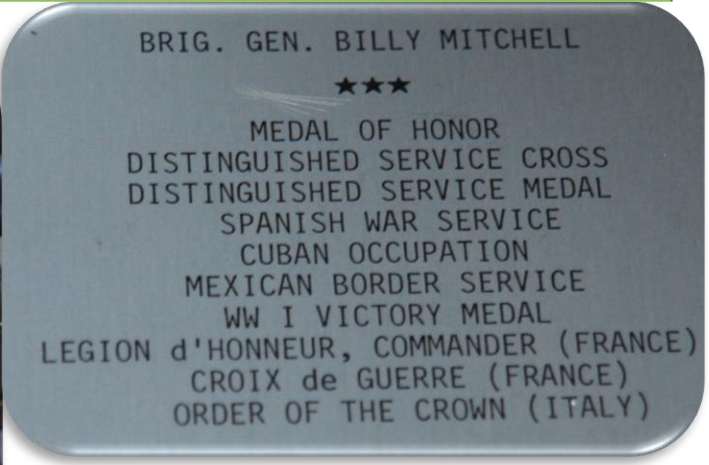

BRIG. GEN. BILLY MITCHELL

★★★

MEDAL OF HONOR
DISTINGUISHED SERVICE CROSS
DISTINGUISHED SERVICE MEDAL
SPANISH WAR SERVICE
CUBAN OCCUPATION
MEXICAN BORDER SERVICE
WW I VICTORY MEDAL
LEGION d'HONNEUR, COMMANDER (FRANCE)
CROIX de GUERRE (FRANCE)
ORDER OF THE CROWN (ITALY)

Legion d' Honneur (French equivalent to U.S. MOH),
Croix de Guerre (French highest VALOR IN BATTLE award)

Key Points: **William Lendrum "Billy" Mitchell** (December 29, 1879 – February 19, 1936) was a US Army general who is regarded as the **father of the United States Air Force**. Mitchell served in France during WWI and commanded all American air combat units in France. **Advocated the ability of bombers to sink battleships** and demonstrated his ideas against stationary ships in 1921. He was court-martialed for insubordination and resigned from the service shortly afterward. The **only individual for whom an American military aircraft, the North American B-25 Mitchell, is named**.

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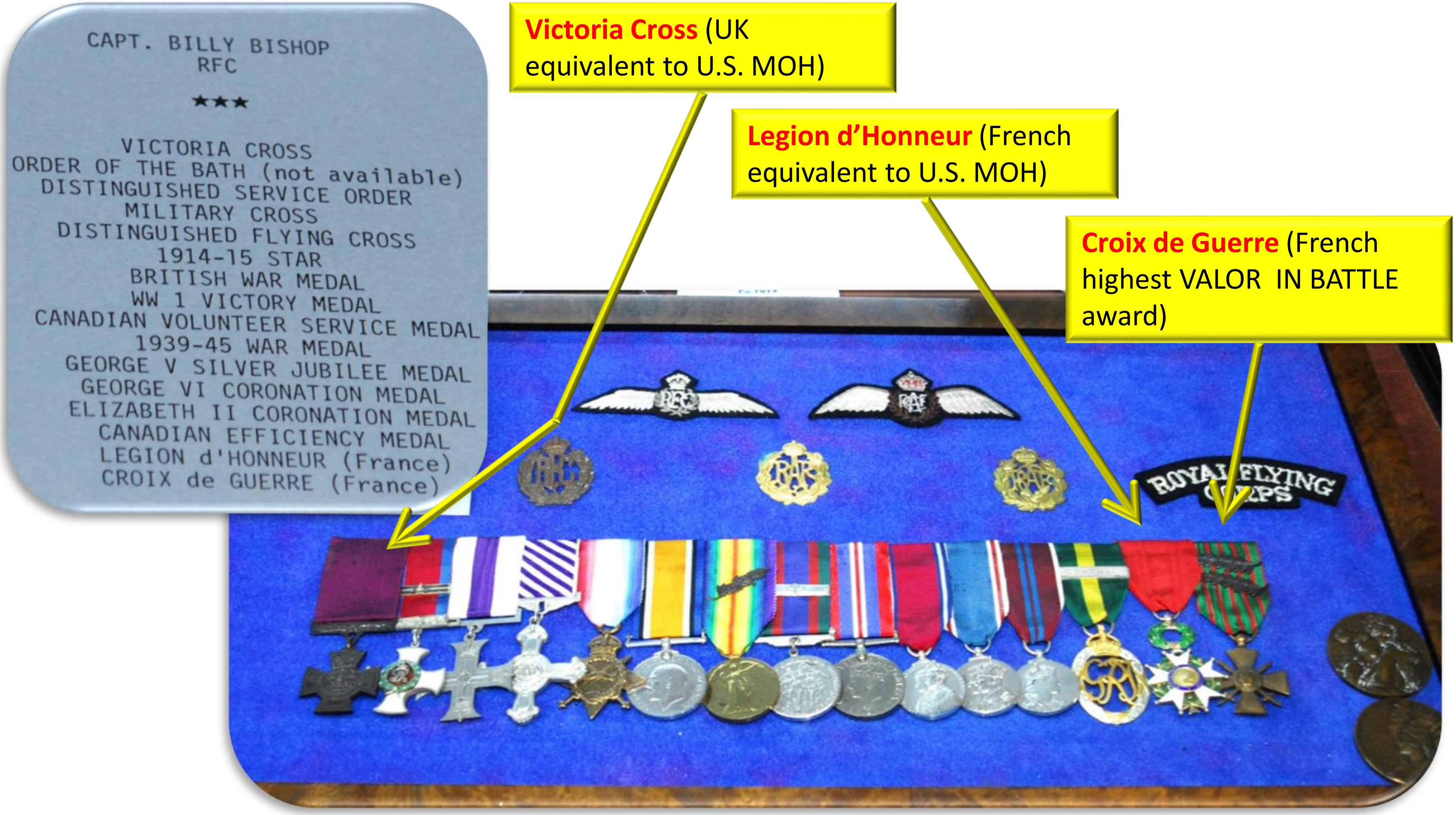

CAPT. BILLY BISHOP
RFC

★★★

VICTORIA CROSS
ORDER OF THE BATH (not available)
DISTINGUISHED SERVICE ORDER
MILITARY CROSS
DISTINGUISHED FLYING CROSS
1914-15 STAR
BRITISH WAR MEDAL
WW 1 VICTORY MEDAL
CANADIAN VOLUNTEER SERVICE MEDAL
1939-45 WAR MEDAL
GEORGE V SILVER JUBILEE MEDAL
GEORGE VI CORONATION MEDAL
ELIZABETH II CORONATION MEDAL
CANADIAN EFFICIENCY MEDAL
LEGION d'HONNEUR (France)
CROIX de GUERRE (France)

Victoria Cross (UK equivalent to U.S. MOH)

Legion d’Honneur (French equivalent to U.S. MOH)

Croix de Guerre (French highest VALOR IN BATTLE award)

Key Points: **Air Marshal William Avery “Billy” Bishop**, 8 February 1894 – 11 September 1956. Bishop was a Canadian flying ace and Victoria Cross recipient of the First World War. He was officially credited with 72 victories, making him the top Canadian ace of the war.

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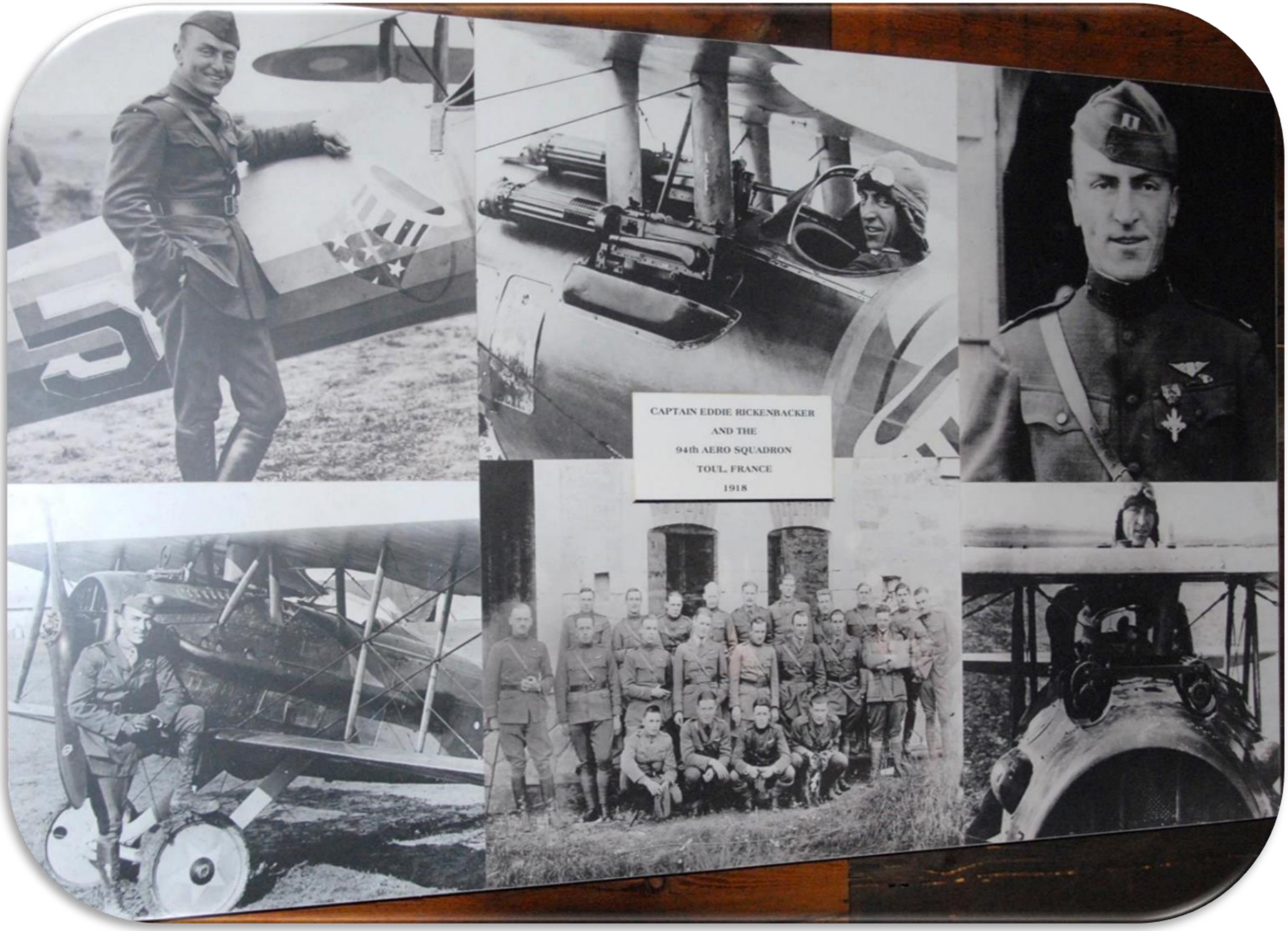
CAPTAIN EDDIE RICKENBACKER
AND THE
94th AERO SQUADRON
TOUL, FRANCE
1918

Key Points: **Captain Eddie Rickenbacker,** 94th Aero Squadron, Toul, France, 1918. WWI - **America's most successful fighter "Ace"** with **26 victories.**

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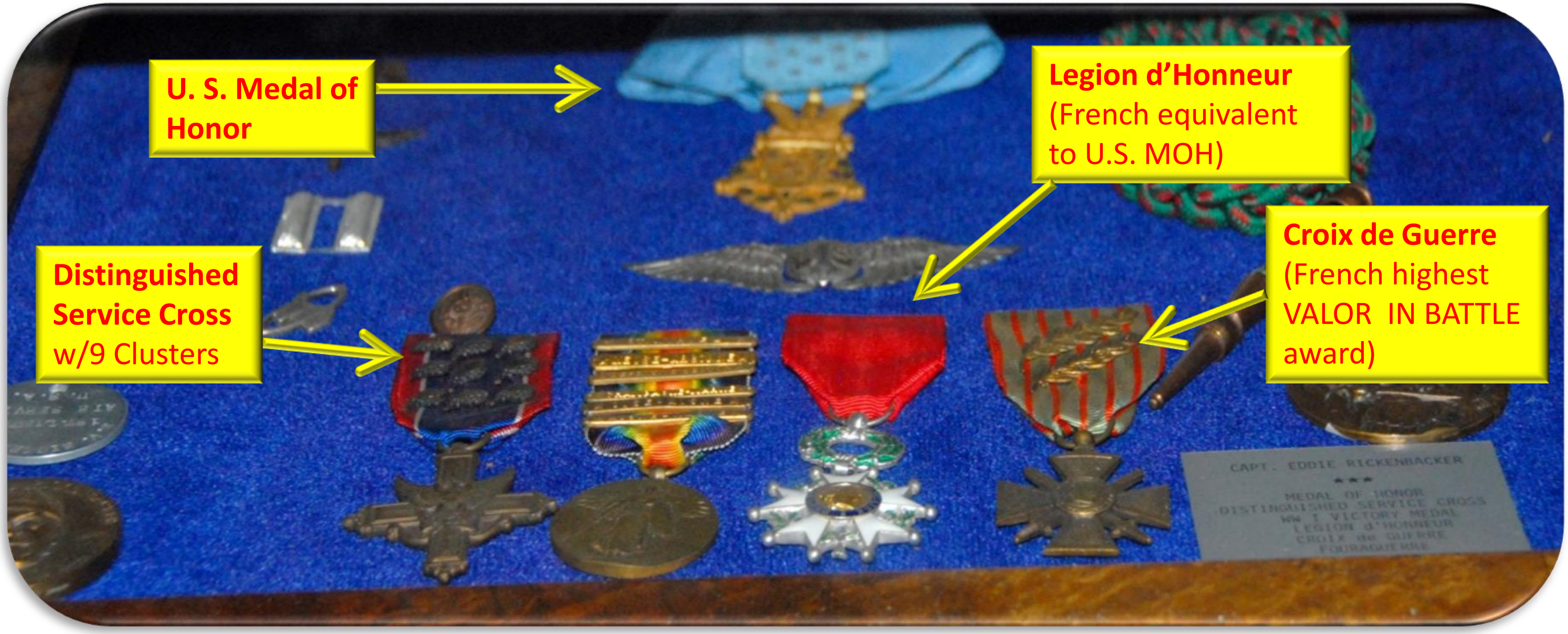
U. S. Medal of Honor
Legion d'Honneur (French equivalent to U.S. MOH)
Croix de Guerre (French highest VALOR IN BATTLE award)
Distinguished Service Cross w/9 Clusters
CAPT. EDDIE RICKENBACKER
★★★
MEDAL OF HONOR
DISTINGUISHED SERVICE CROSS
WW I VICTORY MEDAL
LEGION d'HONNEUR
CROIX de GUERRE
FOURRAGUERE

Key Points: **Captain Eddie Rickenbacker, Medal of Honor, Distinguished Service Cross** (9 clusters)**, WWI Victory Medal** (6 Battle Clasps)**, French Legion of Honor** (Equivalent to US MOH)**, and French Croix de Guerre** (Highest Valor in Battle award w/2 Palms)**.**

After the war, he was a **race car driver** and **automotive designer**, a **government consultant** in military matters and a **pioneer in air transportation**, particularly as the longtime head of **Eastern Air Lines**.

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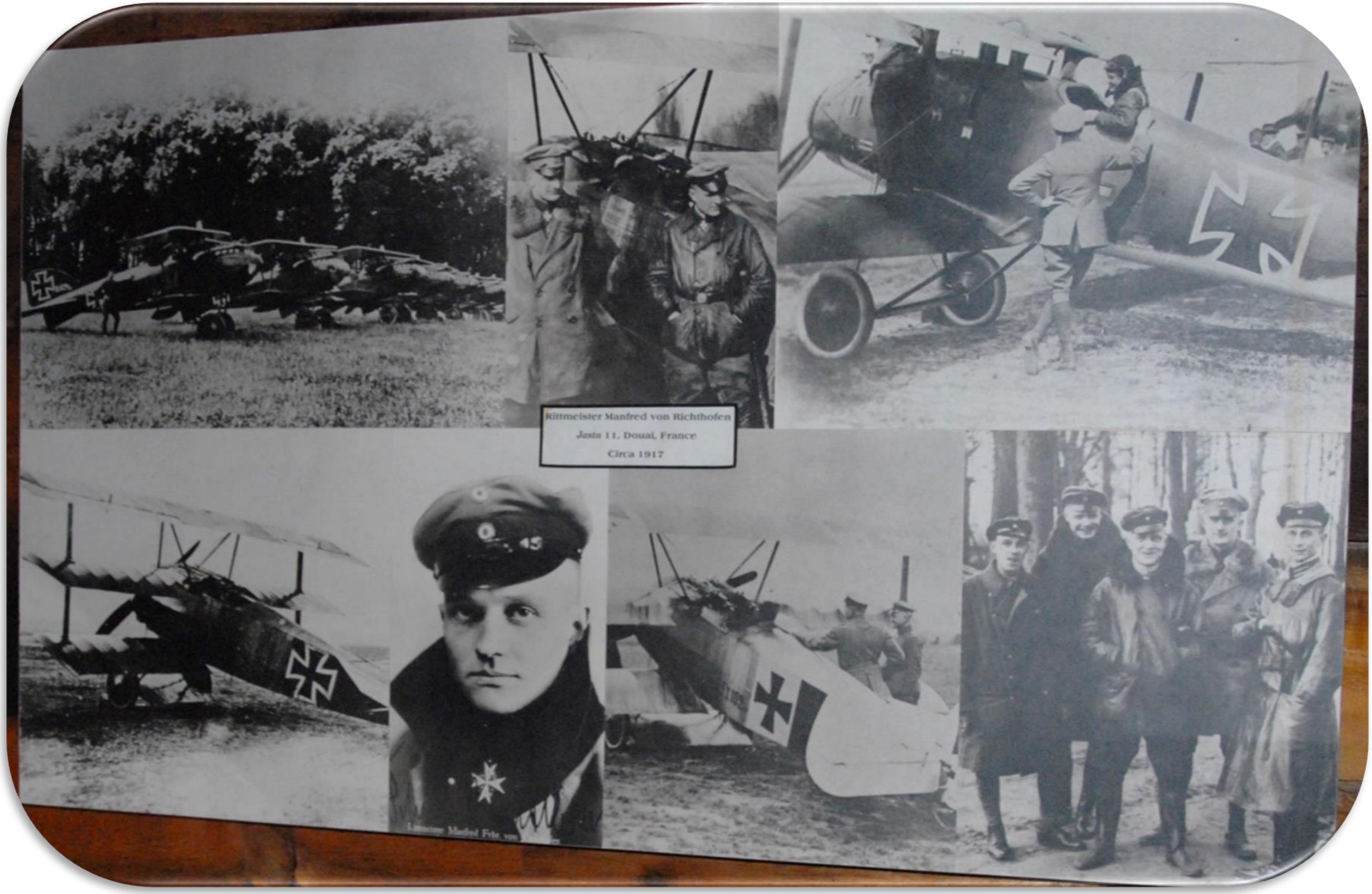
Rittmeister Manfred von Richthofen
Jasta 11, Doual, France
Circa 1917

Key Points: **Rittmeister (Captain) Manfred von Richthofen,** Jasta 11, Doual, France, 1917. WWI - Germany's most successful fighter "Ace" with **80 victories**.

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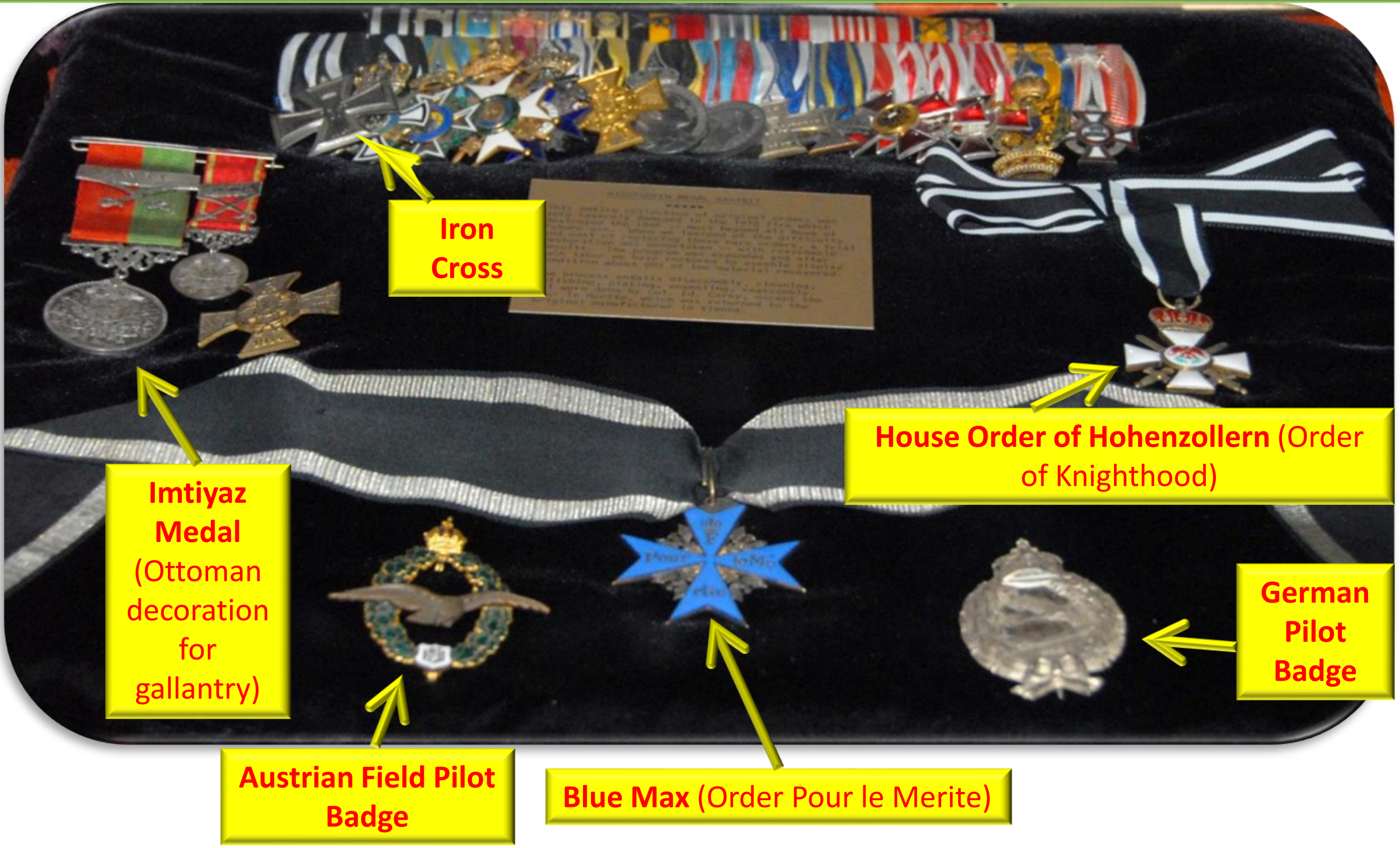

Iron Cross

Imtiyaz Medal (Ottoman decoration for gallantry)

House Order of Hohenzollern (Order of Knighthood)

German Pilot Badge

Austrian Field Pilot Badge

Blue Max (Order Pour le Merite)

Rittmeister (Captain of Calvary) Manfred von Richthofen – 31 medals, awards, clasps and badges. Most are original medals, some reconstructed after museum fire in 1978. Obtained from his sister, Elisabeth/Ilse von Richthofen.

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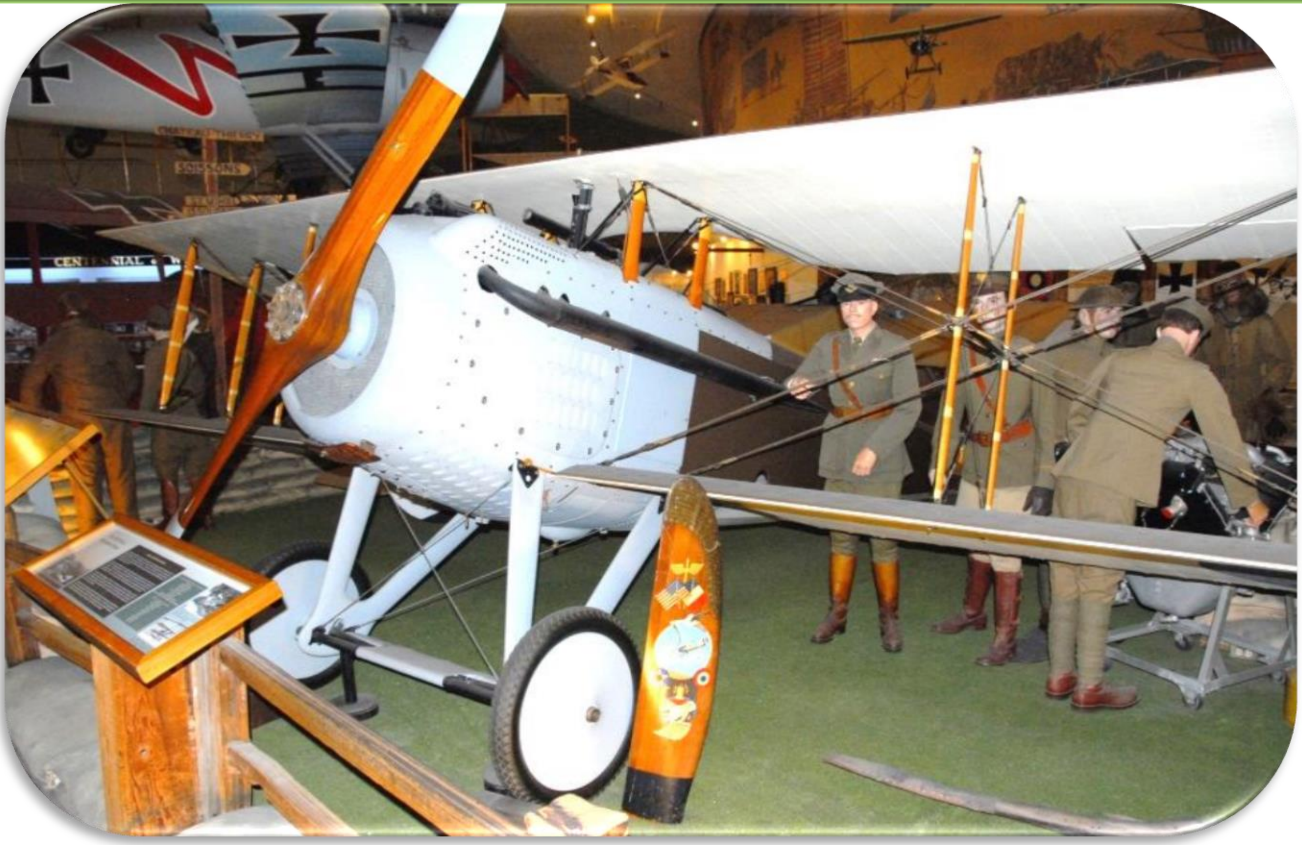

1st flight: 1916
(500+ built)

Key Points: **SPAD VII. c.1** (**Original**) **1916**, Société-pour l'Aviation et ses Derives (**Society for Aviation and its Derivatives**). **Synchronized gun, V-8 engine, 180 hp. Preferred by French and British, 500 in service, including Lafayette Escadrille.**

This: Manufactured in Norwich, England in **1917**. **95% original**, one of the most authentic WWI aircraft in existence. Restored 1990 – Jim and Zona Appleby, Yucca Valley, CA, and the SDASMs Gillespie Field facility.

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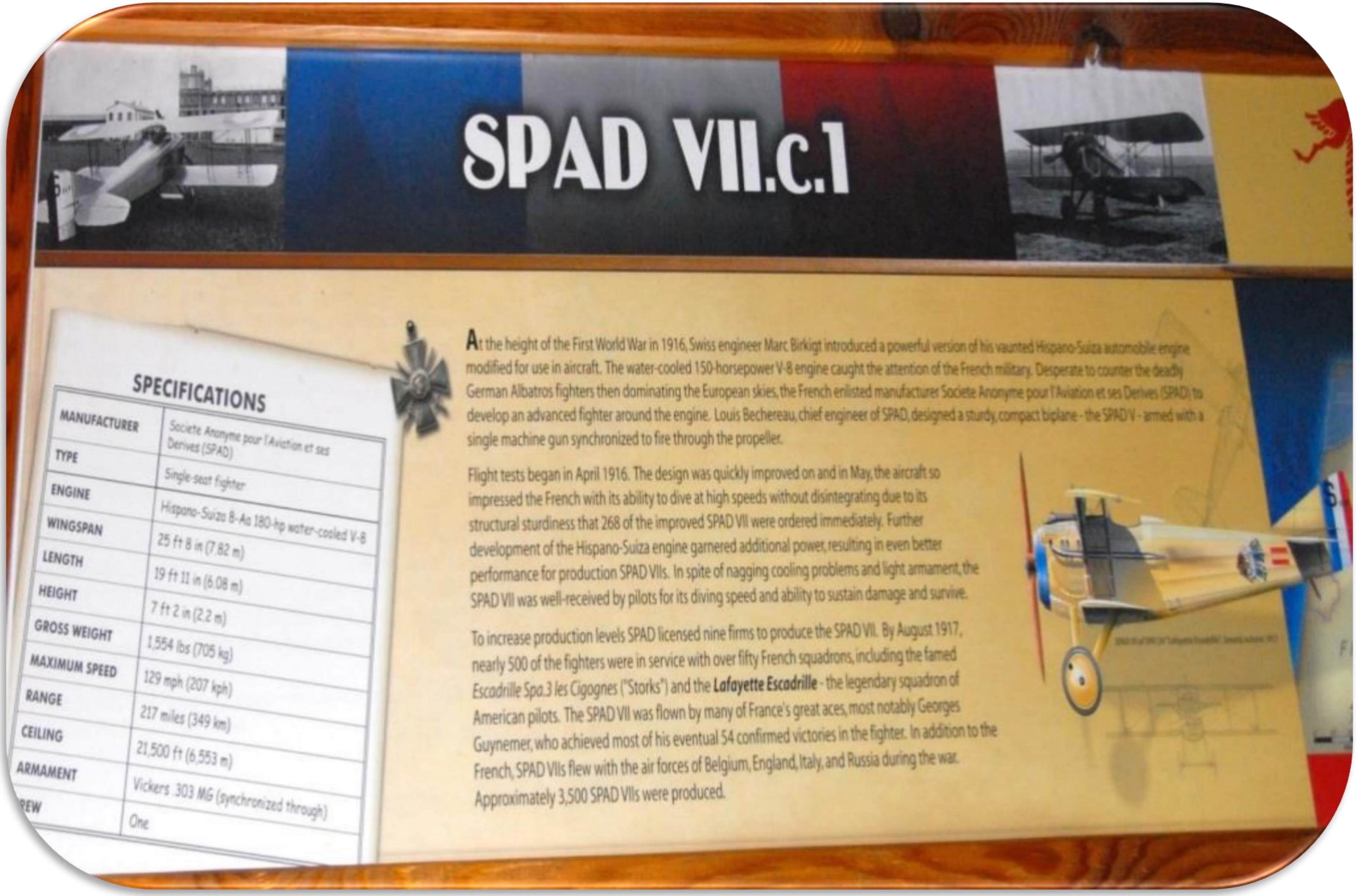

SPAD VII.c1

At the height of the First World War in 1916, Swiss engineer Marc Birkigt introduced a powerful version of his vaunted Hispano-Suiza automobile engine modified for use in aircraft. The water-cooled 150-horsepower V-8 engine caught the attention of the French military. Desperate to counter the deadly German Albatros fighters then dominating the European skies, the French enlisted manufacturer Societe Anonyme pour l'Aviation et ses Derives (SPAD) to develop an advanced fighter around the engine. Louis Bechereau, chief engineer of SPAD, designed a sturdy, compact biplane - the SPAD V - armed with a single machine gun synchronized to fire through the propeller.

Flight tests began in April 1916. The design was quickly improved on and in May, the aircraft so impressed the French with its ability to dive at high speeds without disintegrating due to its structural sturdiness that 268 of the improved SPAD VII were ordered immediately. Further development of the Hispano-Suiza engine garnered additional power, resulting in even better performance for production SPAD VIIs. In spite of nagging cooling problems and light armament, the SPAD VII was well-received by pilots for its diving speed and ability to sustain damage and survive.

To increase production levels SPAD licensed nine firms to produce the SPAD VII. By August 1917, nearly 500 of the fighters were in service with over fifty French squadrons, including the famed *Escadrille Spa.3 les Cigognes* ("Storks") and the ***Lafayette Escadrille*** - the legendary squadron of American pilots. The SPAD VII was flown by many of France's great aces, most notably Georges Guynemer, who achieved most of his eventual 54 confirmed victories in the fighter. In addition to the French, SPAD VIIs flew with the air forces of Belgium, England, Italy, and Russia during the war. Approximately 3,500 SPAD VIIs were produced.

SPECIFICATIONS

MANUFACTURER	Societe Anonyme pour l'Aviation et ses Derives (SPAD)
TYPE	Single-seat fighter
ENGINE	Hispano-Suiza 8-Aa 180-hp water-cooled V-8
WINGSPAN	25 ft 8 in (7.82 m)
LENGTH	19 ft 11 in (6.08 m)
HEIGHT	7 ft 2 in (2.2 m)
GROSS WEIGHT	1,554 lbs (705 kg)
MAXIMUM SPEED	129 mph (207 kph)
RANGE	217 miles (349 km)
CEILING	21,500 ft (6,553 m)
ARMAMENT	Vickers .303 MG (synchronized through)
REW	One

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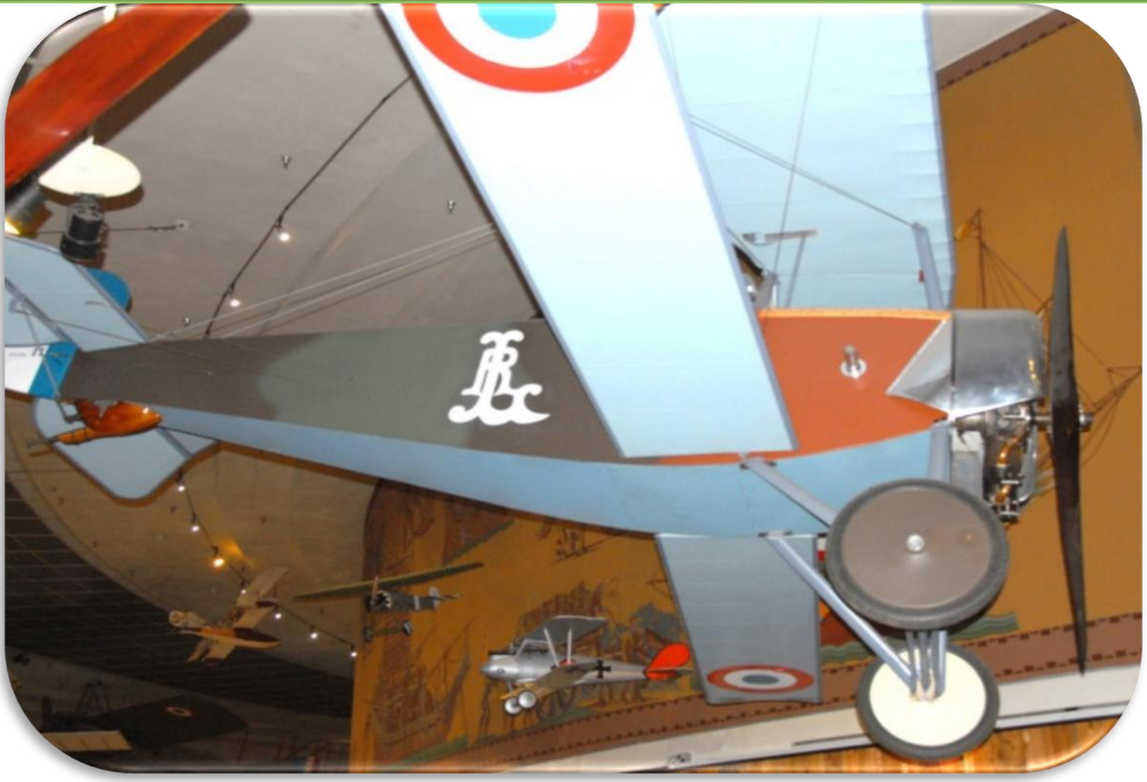

1st flight: 1915
(700 built)

Key Points: **Nieuport 11** (Reproduction) **1915**, French, **designed and built for racing** by Gustave Delage. For combat, a **Lewis gun was installed** to fire above the prop arc. **80 horsepower Le Rhone rotary engine**. **Ended the 'Fokker Scourge' in 1916**. Flown by French, British, Italian, Belgian, Dutch and Russian Air Force's and American volunteers. Approximately 700 built and flown until the end of the war.

This: Is a **flyable** reproduction built by **Walter Addems & Joseph Pfiefer**, Porterville, CA, 1962, donated 1982. "RL" for **Raoul Lufbery, first American ace in WWI**, while flying with the **Lafayette Escadrille**.

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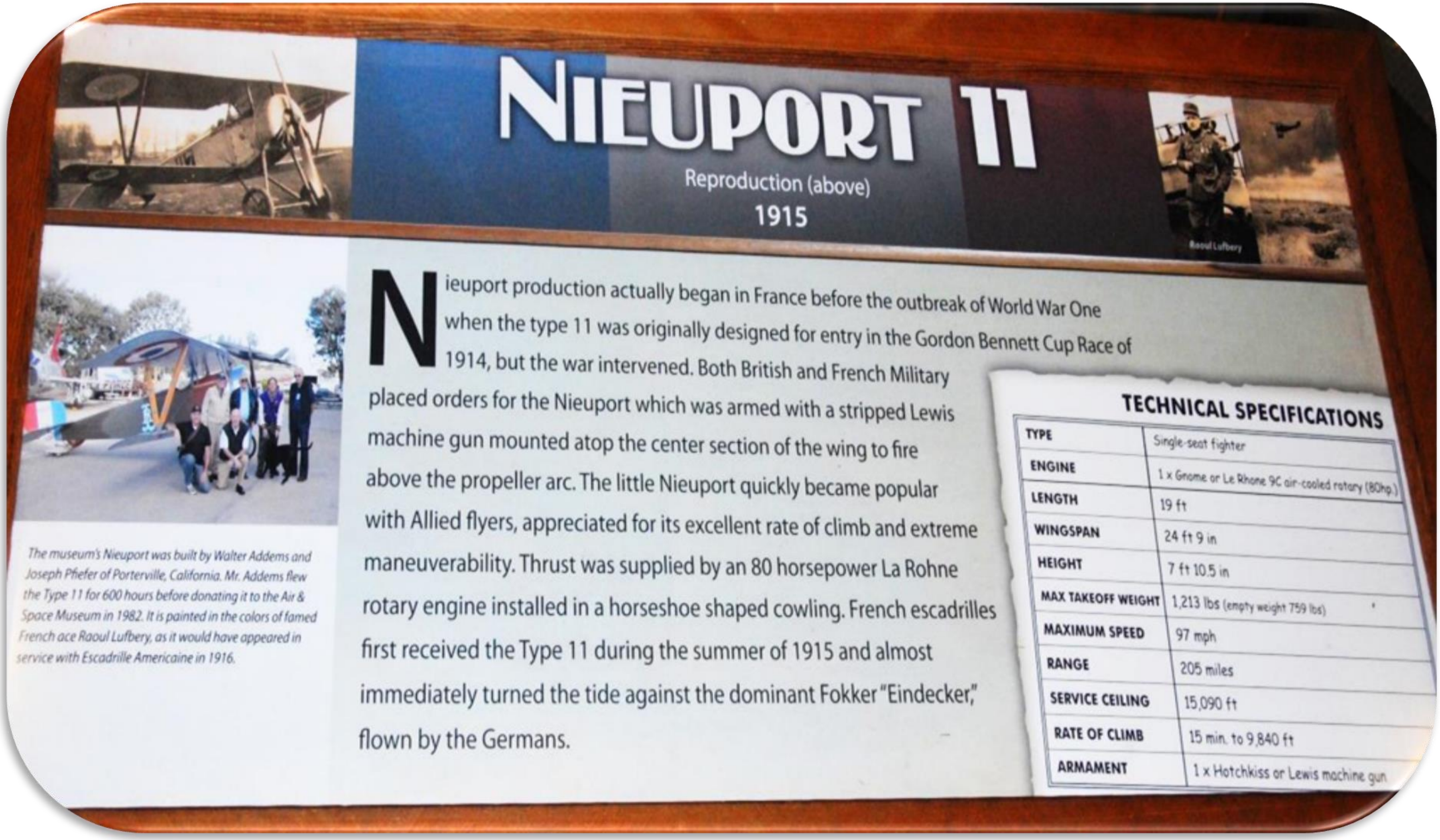

NIEUPORT 11

Reproduction (above)

1915

Raoul Lufbery

Nieuport production actually began in France before the outbreak of World War One when the type 11 was originally designed for entry in the Gordon Bennett Cup Race of 1914, but the war intervened. Both British and French Military placed orders for the Nieuport which was armed with a stripped Lewis machine gun mounted atop the center section of the wing to fire above the propeller arc. The little Nieuport quickly became popular with Allied flyers, appreciated for its excellent rate of climb and extreme maneuverability. Thrust was supplied by an 80 horsepower La Rohne rotary engine installed in a horseshoe shaped cowling. French escadrilles first received the Type 11 during the summer of 1915 and almost immediately turned the tide against the dominant Fokker "Eindecker," flown by the Germans.

The museum's Nieuport was built by Walter Addems and Joseph Pfiefer of Porterville, California. Mr. Addems flew the Type 11 for 600 hours before donating it to the Air & Space Museum in 1982. It is painted in the colors of famed French ace Raoul Lufbery, as it would have appeared in service with Escadrille Americaine in 1916.

TECHNICAL SPECIFICATIONS

TYPE	Single-seat fighter
ENGINE	1 x Gnome or Le Rhone 9C air-cooled rotary (80hp.)
LENGTH	19 ft
WINGSPAN	24 ft 9 in
HEIGHT	7 ft 10.5 in
MAX TAKEOFF WEIGHT	1,213 lbs (empty weight 759 lbs)
MAXIMUM SPEED	97 mph
RANGE	205 miles
SERVICE CEILING	15,090 ft
RATE OF CLIMB	15 min. to 9,840 ft
ARMAMENT	1 x Hotchkiss or Lewis machine gun

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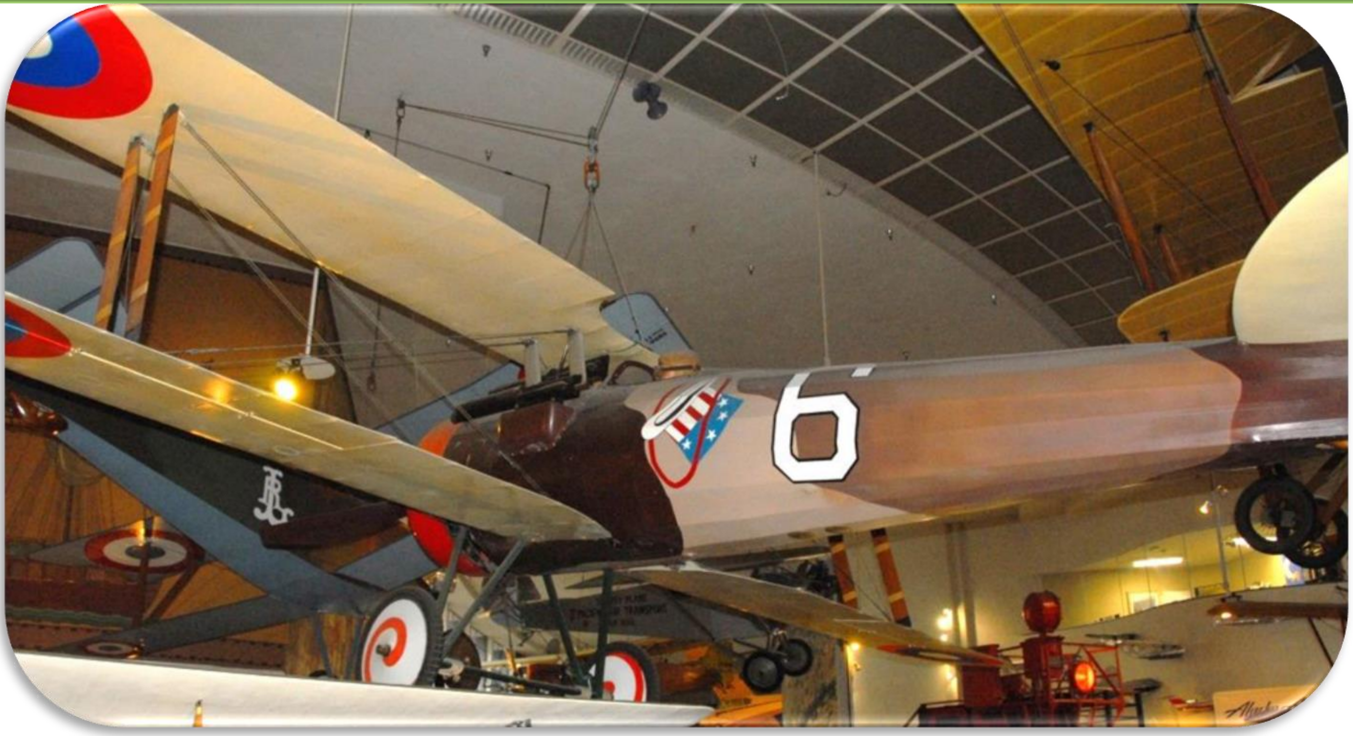

1st flight: 1917
(About 300 built)

Key Points: Nieuport N28C-1 (Original) **1917; first type aircraft used with a US fighter squadron.** Never used by French (preferred SPAD). France **sold 297 to U.S.** who had no fighter airplanes of their own. **One 165 hp 9 cylinder Gnome 9N rotary, two Vickers machine guns. Shot down first enemy for US** in Apr, 1918. **First US fighter aces: Lt Douglas Campbell and Alan Winslow** of the 94th "Hat in the Ring" Aero Squadron. **Captain Eddie Rickenbacker, scored 12 of 26 in Nieuport N28C-1**. **Lt. Quentin Roosevelt, 95th Pursuit Squadron, son of President Theodore Roosevelt, killed in a Nieuport 28.**

This: Built in France, 1918. Markings of Ken Marr, CO, of 94th Squadron. Restoration by George Hunt. Used in movie, ***The Dawn Patrol***. Purchased in 1979.

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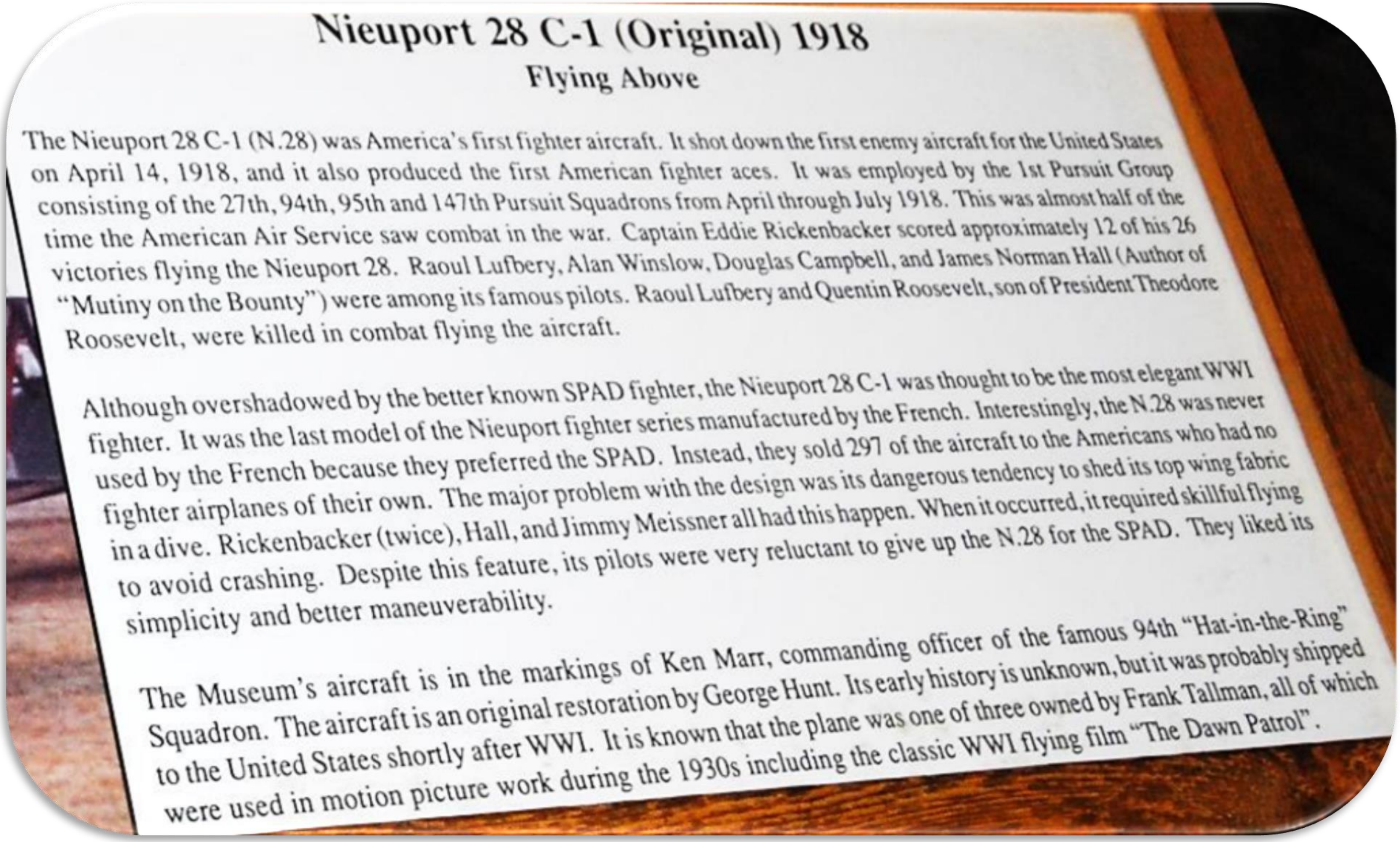

Nieuport 28 C-1 (Original) 1918

Flying Above

The Nieuport 28 C-1 (N.28) was America's first fighter aircraft. It shot down the first enemy aircraft for the United States on April 14, 1918, and it also produced the first American fighter aces. It was employed by the 1st Pursuit Group consisting of the 27th, 94th, 95th and 147th Pursuit Squadrons from April through July 1918. This was almost half of the time the American Air Service saw combat in the war. Captain Eddie Rickenbacker scored approximately 12 of his 26 victories flying the Nieuport 28. Raoul Lufbery, Alan Winslow, Douglas Campbell, and James Norman Hall (Author of "Mutiny on the Bounty") were among its famous pilots. Raoul Lufbery and Quentin Roosevelt, son of President Theodore Roosevelt, were killed in combat flying the aircraft.

Although overshadowed by the better known SPAD fighter, the Nieuport 28 C-1 was thought to be the most elegant WWI fighter. It was the last model of the Nieuport fighter series manufactured by the French. Interestingly, the N.28 was never used by the French because they preferred the SPAD. Instead, they sold 297 of the aircraft to the Americans who had no fighter airplanes of their own. The major problem with the design was its dangerous tendency to shed its top wing fabric in a dive. Rickenbacker (twice), Hall, and Jimmy Meissner all had this happen. When it occurred, it required skillful flying to avoid crashing. Despite this feature, its pilots were very reluctant to give up the N.28 for the SPAD. They liked its simplicity and better maneuverability.

The Museum's aircraft is in the markings of Ken Marr, commanding officer of the famous 94th "Hat-in-the-Ring" Squadron. The aircraft is an original restoration by George Hunt. Its early history is unknown, but it was probably shipped to the United States shortly after WWI. It is known that the plane was one of three owned by Frank Tallman, all of which were used in motion picture work during the 1930s including the classic WWI flying film "The Dawn Patrol".

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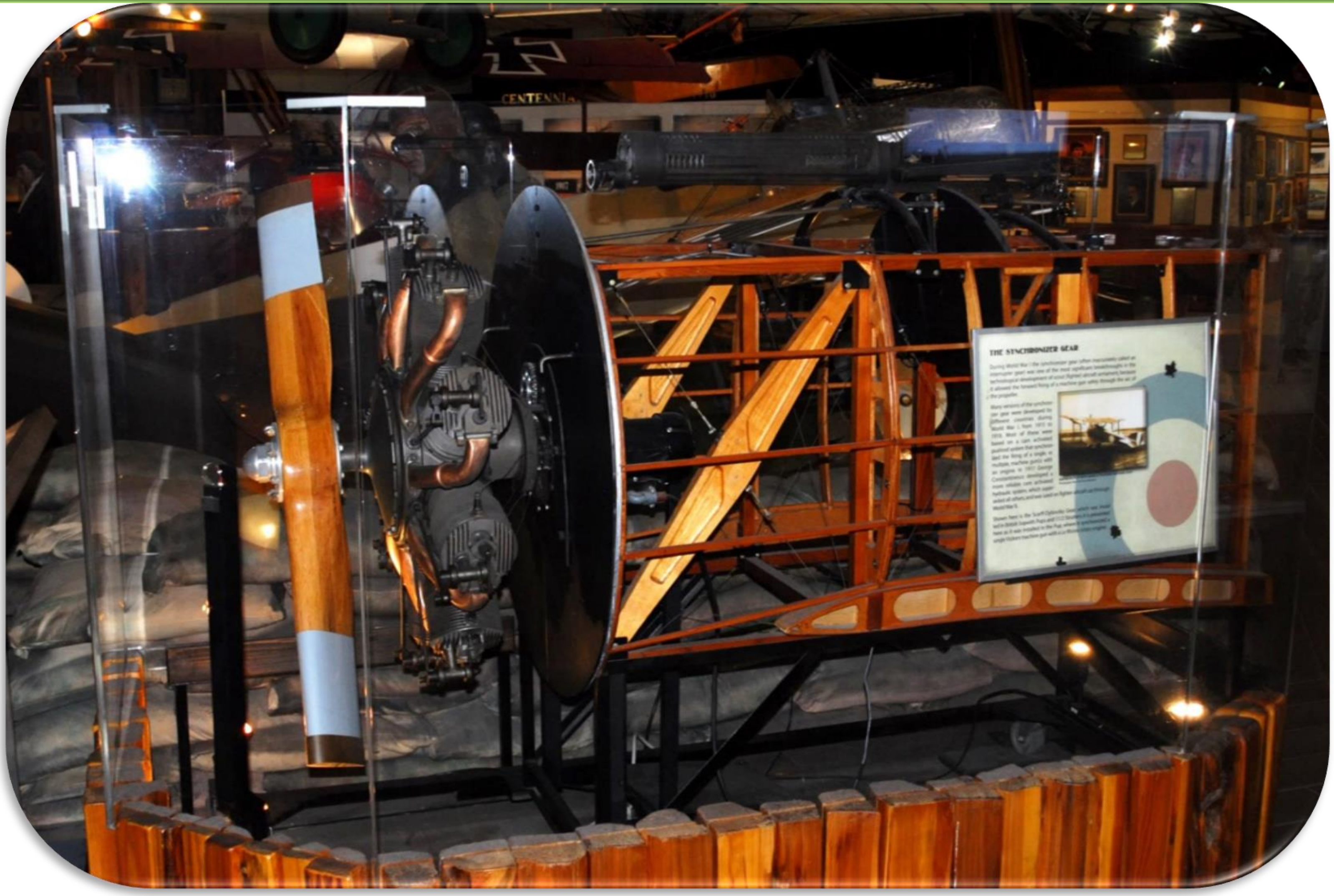
THE SYNCHRONIZER GEAR

Key Points: Display showing a **demonstration of a synchronizer gear** with Vickers machine gun and Le Rhone rotary engine. Similar synchronizer gear used from **1915 thru WWII**.

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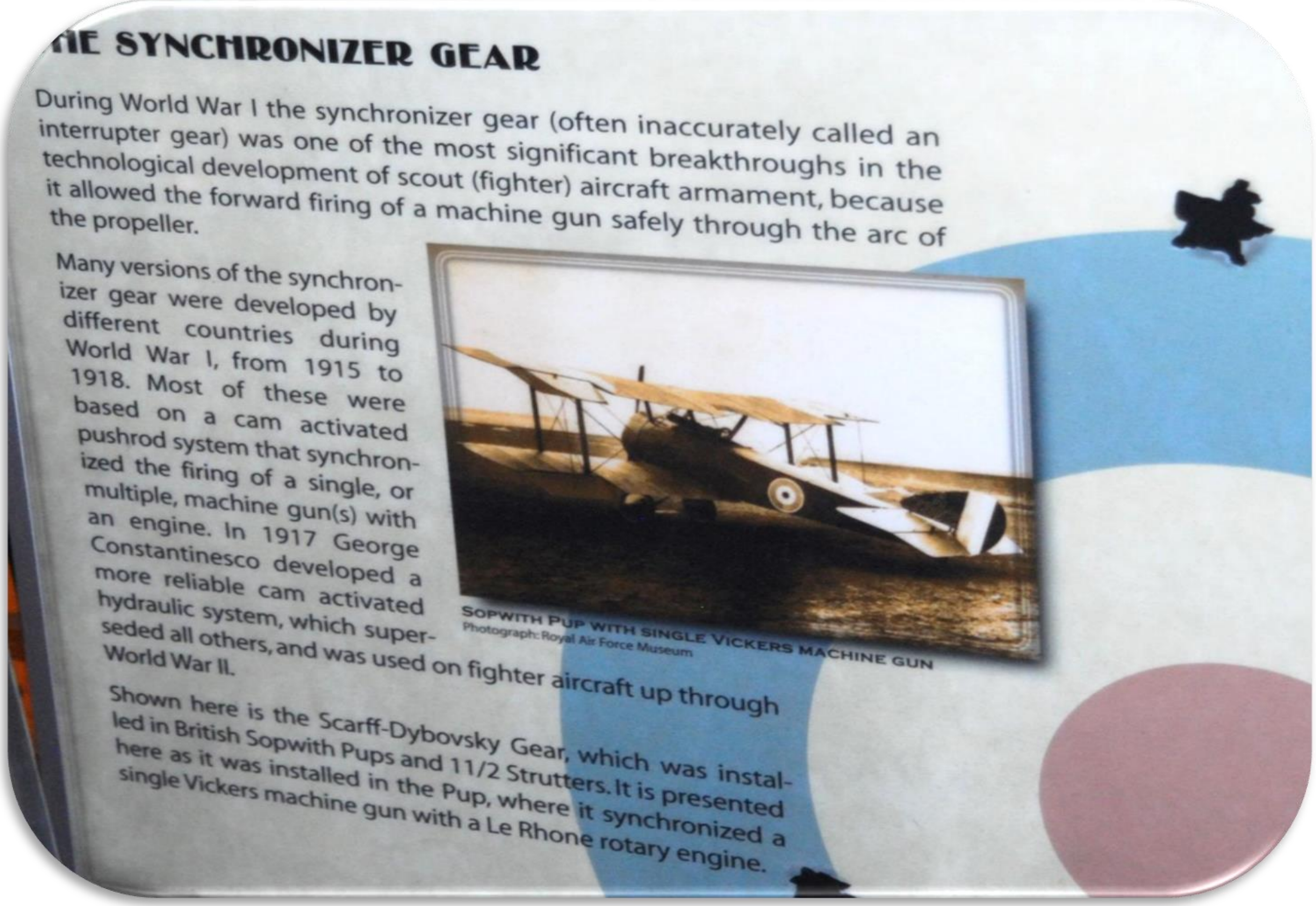


HE SYNCHRONIZER GEAR

During World War I the synchronizer gear (often inaccurately called an interrupter gear) was one of the most significant breakthroughs in the technological development of scout (fighter) aircraft armament, because it allowed the forward firing of a machine gun safely through the arc of the propeller.

Many versions of the synchronizer gear were developed by different countries during World War I, from 1915 to 1918. Most of these were based on a cam activated pushrod system that synchronized the firing of a single, or multiple, machine gun(s) with an engine. In 1917 George Constantinesco developed a more reliable cam activated hydraulic system, which superseded all others, and was used on fighter aircraft up through World War II.

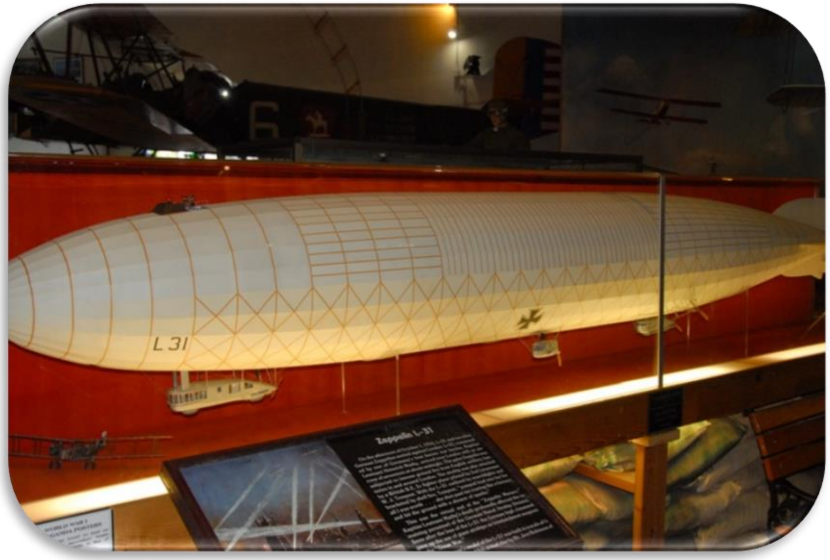
SOPWITH PUP WITH SINGLE VICKERS MACHINE GUN

Photograph: Royal Air Force Museum

Shown here is the Scarff-Dybovsky Gear, which was installed in British Sopwith Pups and 11/2 Strutters. It is presented here as it was installed in the Pup, where it synchronized a single Vickers machine gun with a Le Rhone rotary engine.

Key Points: Synchronizer Gear. One of the most **significant technological developments in aircraft armament** in WWI. Allowed firing of fixed machine gun through propeller arc allowing **better aiming by the pilot and ammo fed from ammo can**.

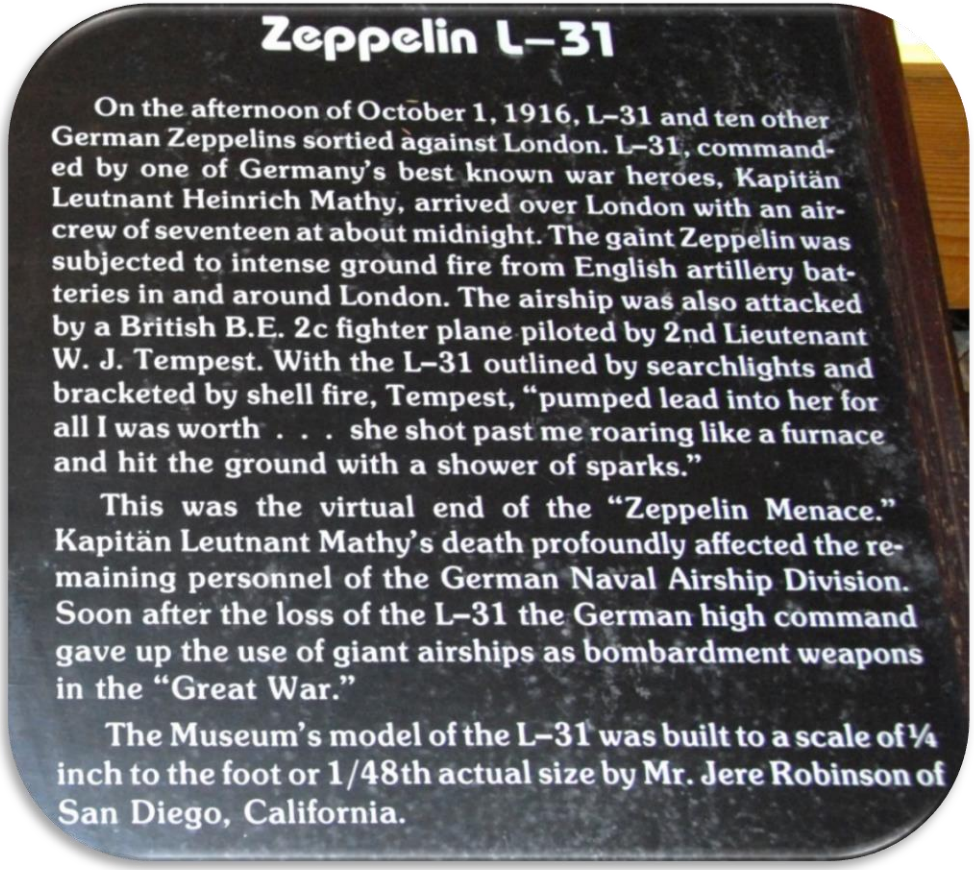
World War I Gallery



1st flight: 1914
(About 162 built)

Key Points: **Zeppelin L-31.** L-31 + 10 other zeppelins attacked London, **Oct 1916**. War Hero, **Kapitan Leutnant Heinrich Mathy killed** when L-31 was shot down. This **virtually ended the airship threat**.

Key Points: Zeppelins, **first strategic bomber force**. Germans had 14 airship bases. Filled with **hydrogen gas** which was a fatal flaw.



Zeppelin L–31

On the afternoon of October 1, 1916, L–31 and ten other German Zeppelins sortied against London. L–31, commanded by one of Germany's best known war heroes, Kapitän Leutnant Heinrich Mathy, arrived over London with an aircrew of seventeen at about midnight. The gaint Zeppelin was subjected to intense ground fire from English artillery batteries in and around London. The airship was also attacked by a British B.E. 2c fighter plane piloted by 2nd Lieutenant W. J. Tempest. With the L–31 outlined by searchlights and bracketed by shell fire, Tempest, "pumped lead into her for all I was worth . . . she shot past me roaring like a furnace and hit the ground with a shower of sparks."

This was the virtual end of the "Zeppelin Menace." Kapitän Leutnant Mathy's death profoundly affected the remaining personnel of the German Naval Airship Division. Soon after the loss of the L–31 the German high command gave up the use of giant airships as bombardment weapons in the "Great War."

The Museum's model of the L–31 was built to a scale of ¼ inch to the foot or 1/48th actual size by Mr. Jere Robinson of San Diego, California.

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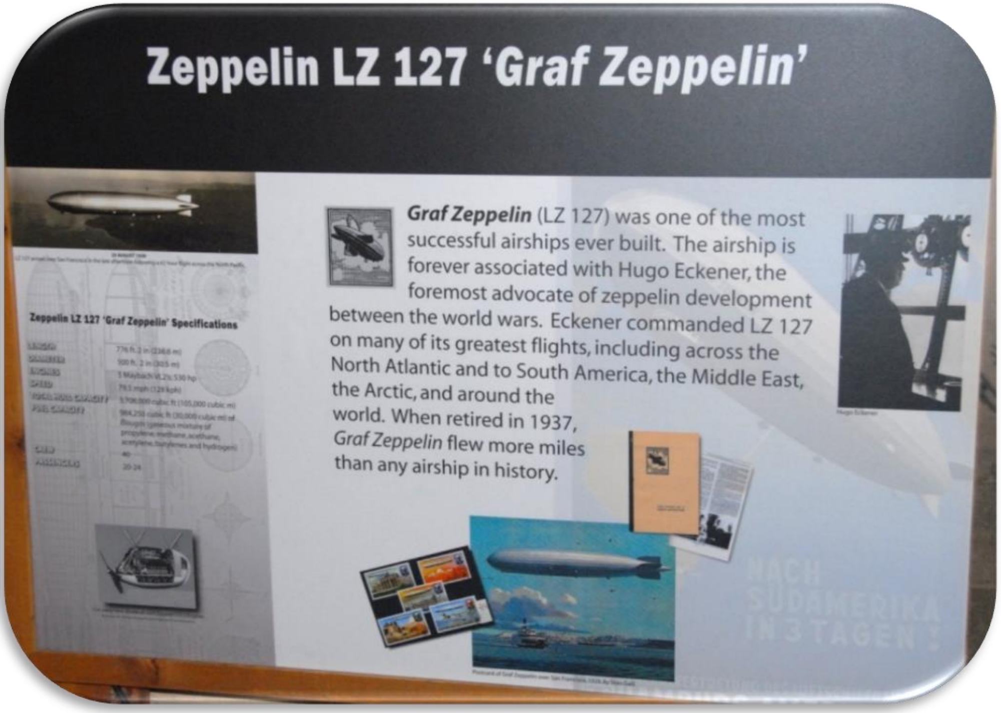
World War I Gallery

ZR-1
U.S.NAVY
GRAF ZEPPELIN



Zeppelin LZ 127 'Graf Zeppelin'

Graf Zeppelin (LZ 127) was one of the most successful airships ever built. The airship is forever associated with Hugo Eckener, the foremost advocate of zeppelin development between the world wars. Eckener commanded LZ 127 on many of its greatest flights, including across the North Atlantic and to South America, the Middle East, the Arctic, and around the world. When retired in 1937, *Graf Zeppelin* flew more miles than any airship in history.

Zeppelin LZ 127 'Graf Zeppelin' Specifications

Key Points: "**Graf Zeppelin**", **LZ 127**. 1928 to 1937, **Hugo Eckener flew it around the world**. More miles flown than any other airship. 776' long, 100' diameter. **79 mph with 5 engines. Crew of 40; with 20-24 passengers**.

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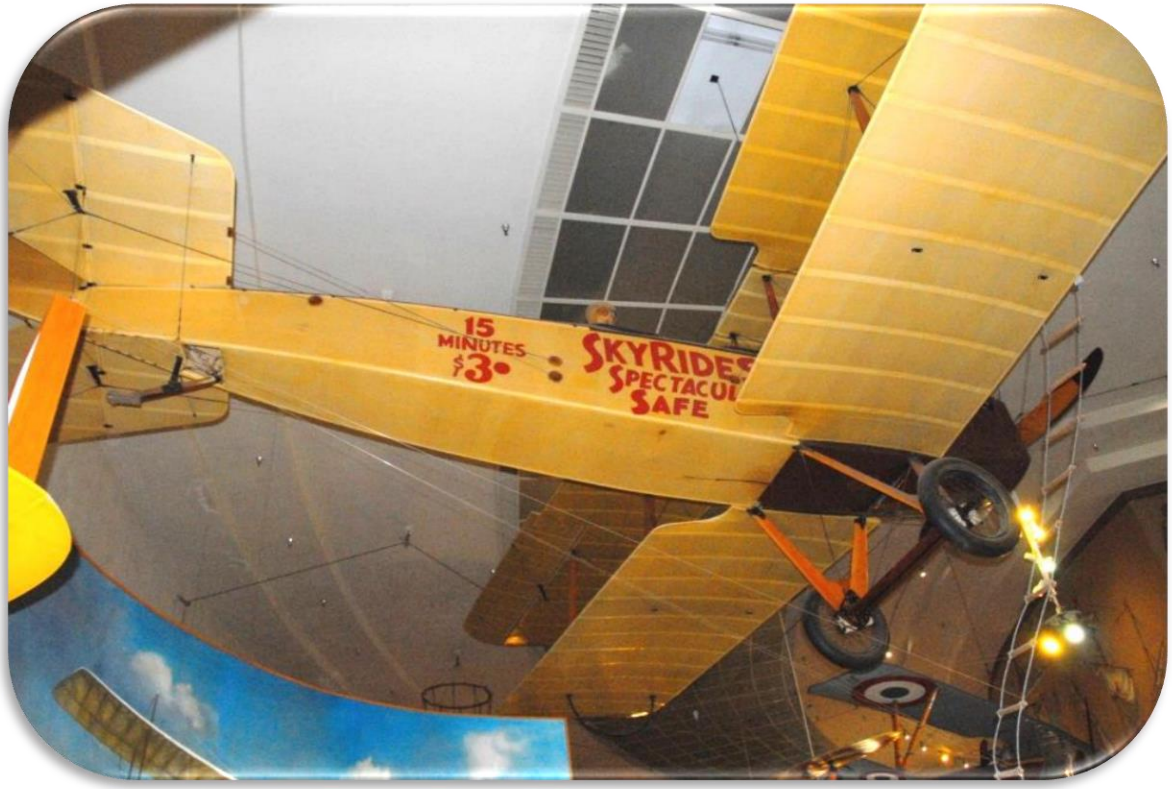
Golden Age Gallery

1918 to 1939

Golden Age Gallery



1st flight: 1916
(1601 built)

Key Points: **Lincoln-Standard J-1, 1916** (**Original**) Standard Aircraft Co. of Plainfield, New Jersey; similar to JN-4D (Jenny); phased out during WWI due to engine fires. After the war, in 1918, 1000+ J-1s in storage. **1919, J-1's sold to civilians, refitted engines to 150 hp** liquid-cooled Wright-Hispano V-8. **1921**, modified to seat 3 & 4 pax, engine **horsepower increased to 220**. **Plane of choice for Charles Lindbergh and Bud Gurney**.

This: Built in 1918, purchased from John M. Larsen in **1978**. **Used in movie *Spirit of St Louis*** and ***It's a Mad Mad Mad Mad World***; and according to letters from Bud Gurney, it **has been flown by Gurney and Charles Lindbergh**.

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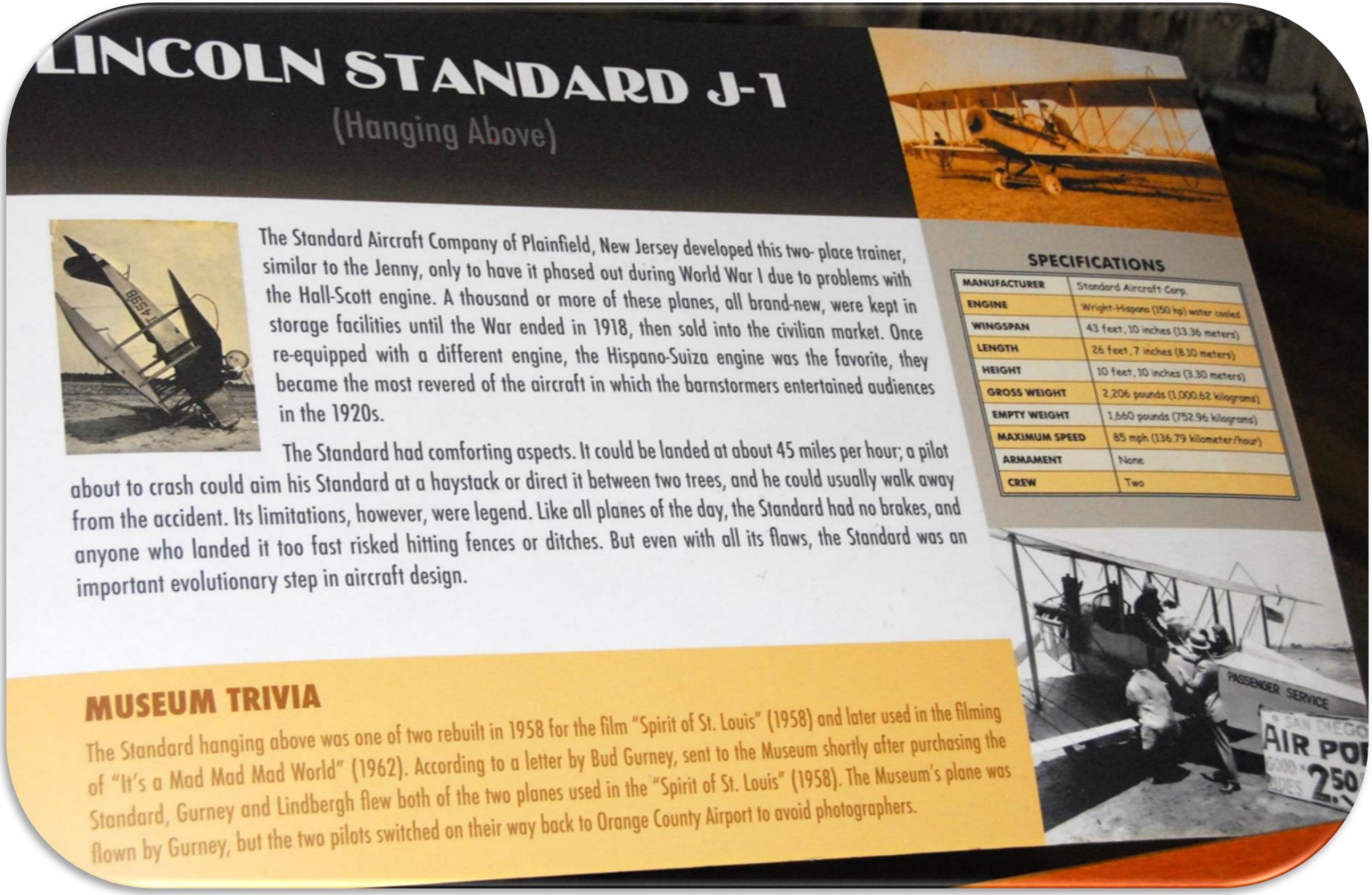
Golden Age Gallery



LINCOLN STANDARD J-1

(Hanging Above)

The Standard Aircraft Company of Plainfield, New Jersey developed this two- place trainer, similar to the Jenny, only to have it phased out during World War I due to problems with the Hall-Scott engine. A thousand or more of these planes, all brand-new, were kept in storage facilities until the War ended in 1918, then sold into the civilian market. Once re-equipped with a different engine, the Hispano-Suiza engine was the favorite, they became the most revered of the aircraft in which the barnstormers entertained audiences in the 1920s.

The Standard had comforting aspects. It could be landed at about 45 miles per hour; a pilot about to crash could aim his Standard at a haystack or direct it between two trees, and he could usually walk away from the accident. Its limitations, however, were legend. Like all planes of the day, the Standard had no brakes, and anyone who landed it too fast risked hitting fences or ditches. But even with all its flaws, the Standard was an important evolutionary step in aircraft design.

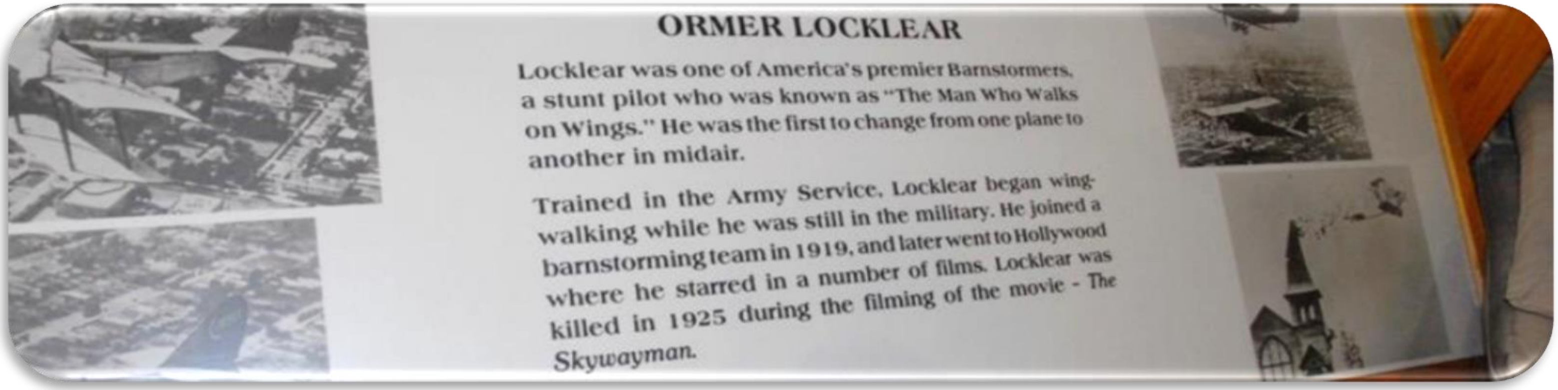
SPECIFICATIONS

MANUFACTURER	Standard Aircraft Corp.
ENGINE	Wright-Hispano (150 hp) water cooled
WINGSPAN	43 feet, 10 inches (13.36 meters)
LENGTH	26 feet, 7 inches (8.10 meters)
HEIGHT	10 feet, 10 inches (3.30 meters)
GROSS WEIGHT	2,206 pounds (1,000.62 kilograms)
EMPTY WEIGHT	1,660 pounds (752.96 kilograms)
MAXIMUM SPEED	85 mph (136.79 kilometer/hour)
ARMAMENT	None
CREW	Two

MUSEUM TRIVIA

The Standard hanging above was one of two rebuilt in 1958 for the film "Spirit of St. Louis" (1958) and later used in the filming of "It's a Mad Mad Mad World" (1962). According to a letter by Bud Gurney, sent to the Museum shortly after purchasing the Standard, Gurney and Lindbergh flew both of the two planes used in the "Spirit of St. Louis" (1958). The Museum's plane was flown by Gurney, but the two pilots switched on their way back to Orange County Airport to avoid photographers.

Golden Age Gallery

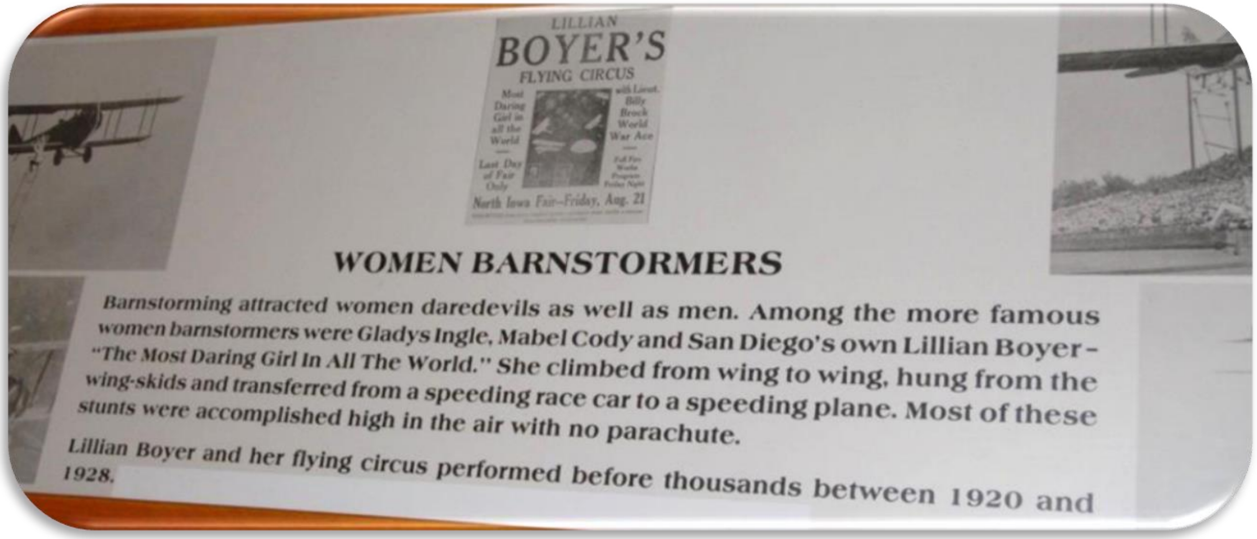


ORMER LOCKLEAR

Locklear was one of America's premier Barnstormers, a stunt pilot who was known as "The Man Who Walks on Wings." He was the first to change from one plane to another in midair.

Trained in the Army Service, Locklear began wing-walking while he was still in the military. He joined a barnstorming team in 1919, and later went to Hollywood where he starred in a number of films. Locklear was killed in 1925 during the filming of the movie - *The Skywayman.*

Key Points: **Ormer Locklear** (1891 – 1920). **First to change planes in mid air**. Hollywood stuntman, many movies. Killed while filming movie ***Skywayman,*** Aug 2, 1920.



LILLIAN
BOYER'S
FLYING CIRCUS
Most Daring Girl in all the World
with Lieut. Billy Brock World War Ace
Last Day of Fair Only
North Iowa Fair—Friday, Aug. 21

WOMEN BARNSTORMERS

Barnstorming attracted women daredevils as well as men. Among the more famous women barnstormers were Gladys Ingle, Mabel Cody and San Diego's own Lillian Boyer – "The Most Daring Girl In All The World." She climbed from wing to wing, hung from the wing-skids and transferred from a speeding race car to a speeding plane. Most of these stunts were accomplished high in the air with no parachute.

Lillian Boyer and her flying circus performed before thousands between 1920 and 1928.

Key Points: **Lillian Boyer** (1901 – 1989), **San Diego local**. Performed **wing to wing transfer, hung from wing skids, transfer from car to plane** without parachute. **Performed with Flying Circus 1920 to 1928**.

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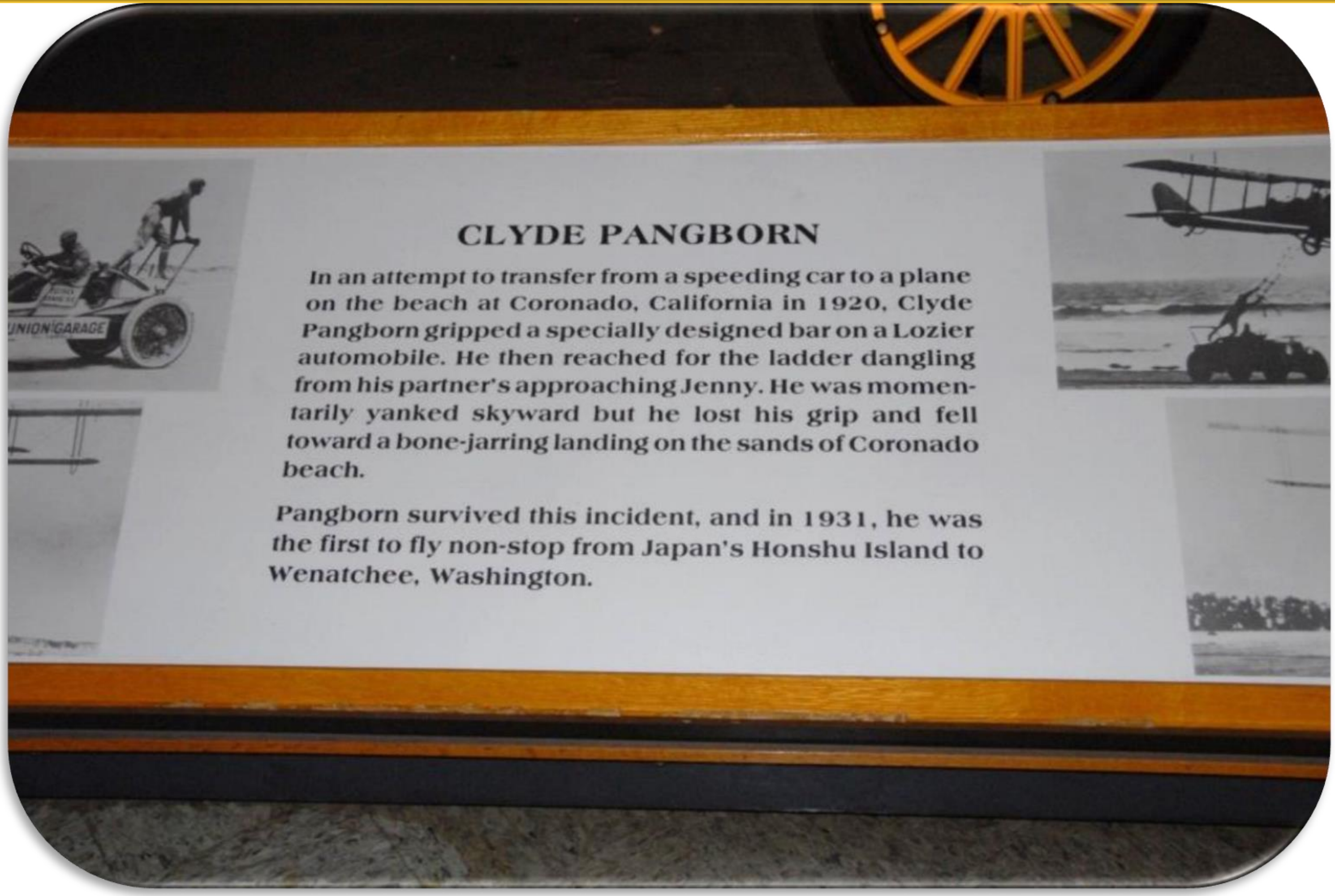
Golden Age Gallery



CLYDE PANGBORN

In an attempt to transfer from a speeding car to a plane on the beach at Coronado, California in 1920, Clyde Pangborn gripped a specially designed bar on a Lozier automobile. He then reached for the ladder dangling from his partner's approaching Jenny. He was momentarily yanked skyward but he lost his grip and fell toward a bone-jarring landing on the sands of Coronado beach.

Pangborn survived this incident, and in 1931, he was the first to fly non-stop from Japan's Honshu Island to Wenatchee, Washington.

Key Points: **Clyde Pangborn** (1895 – 1958). In 1920, slipped in auto-to-plane transfer on **Coronado Beach**, survived. 1931, first to fly non-stop from Japan to Washington State.

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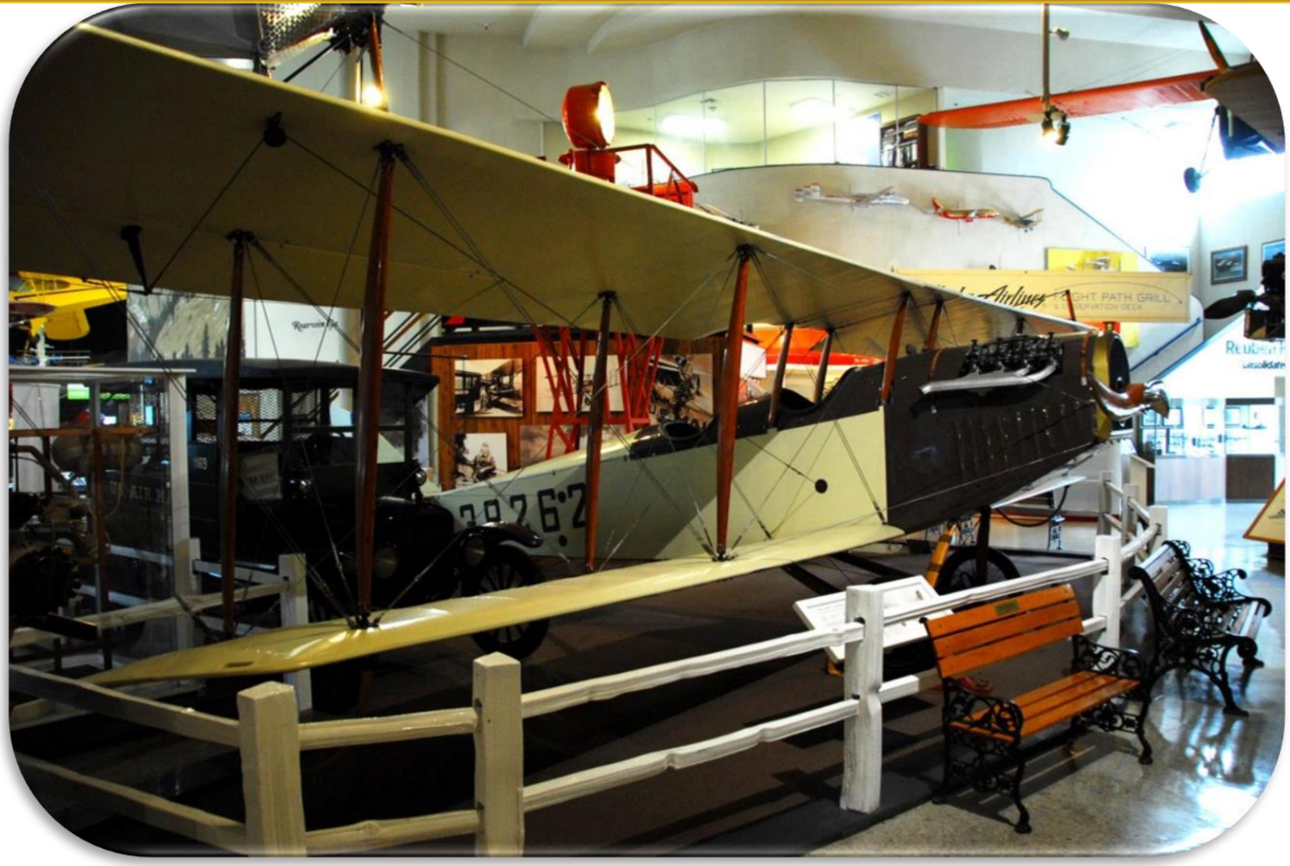

1st flight: 1915
(6000+ built)

Key Points: **Curtiss JN-4D Jenny** (**Original**). **Most used trainer in US** prior WWI. Production started in **1915** by Curtiss Aeroplane Co. of Hammondsport, New York. **95% of U.S. pilots (including Lindbergh) learned to fly in the Jenny**. 90 hp liquid-cooled Curtiss OX-5 V-8. **First Army aircraft used in combat** (Pancho Villa Raid, 1916). **Flew the first Air Mail route** from Washington, D.C. to Philadelphia and New York in 1918.

This: Built in **1917** with OXX-6 engine. Used in movie ***Spirit of St. Louis*** with Jimmy Stewart, 1957. Donated by Johan M. Larsen, 1978. **Lindbergh reportedly flew**.

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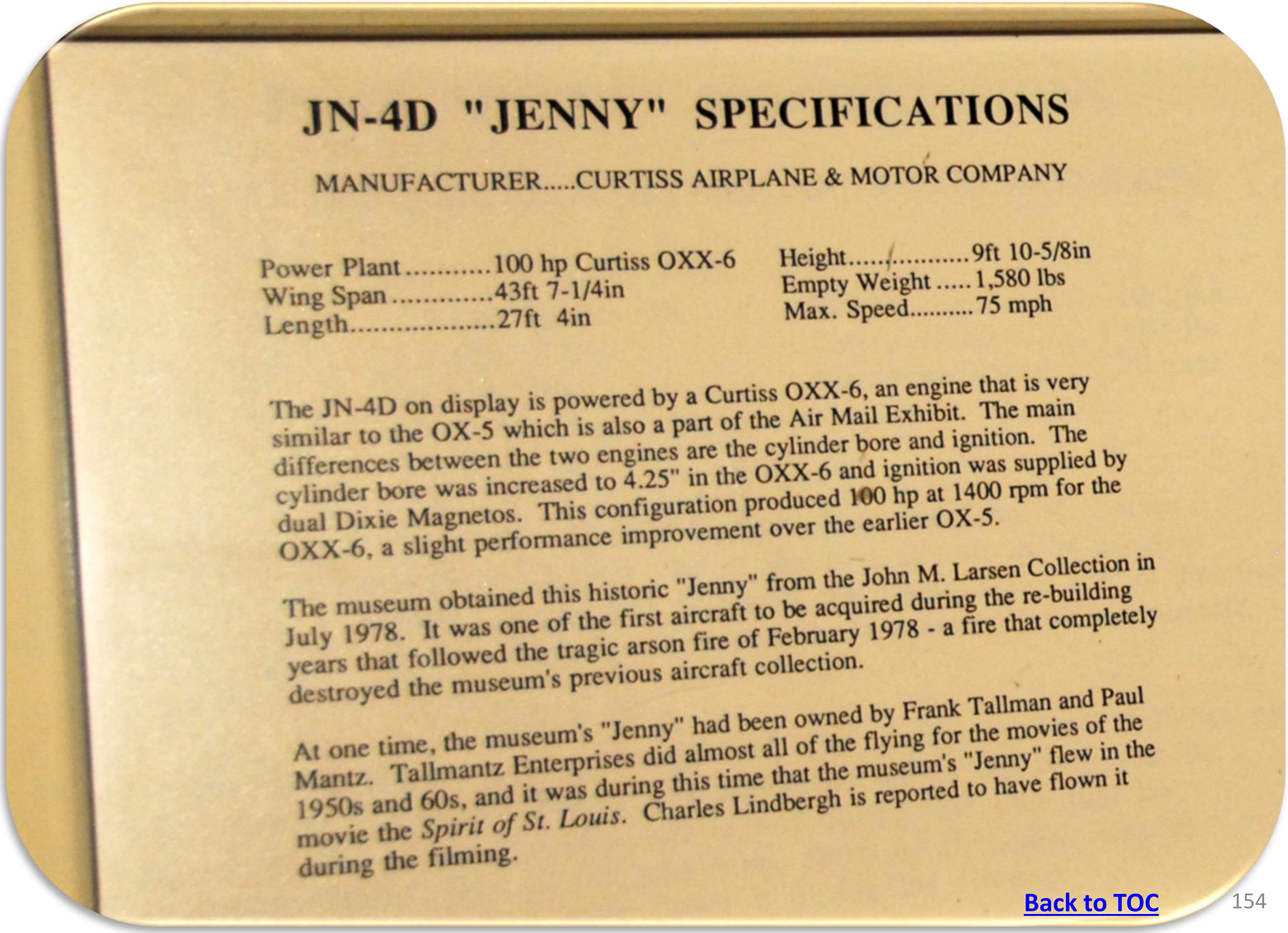
Golden Age Gallery



JN-4D "JENNY" SPECIFICATIONS

MANUFACTURER.....CURTISS AIRPLANE & MOTOR COMPANY

Power Plant............100 hp Curtiss OXX-6
Wing Span..............43ft 7-1/4in
Length....................27ft 4in

Height.....................9ft 10-5/8in
Empty Weight.....1,580 lbs
Max. Speed..........75 mph

The JN-4D on display is powered by a Curtiss OXX-6, an engine that is very similar to the OX-5 which is also a part of the Air Mail Exhibit. The main differences between the two engines are the cylinder bore and ignition. The cylinder bore was increased to 4.25" in the OXX-6 and ignition was supplied by dual Dixie Magnetos. This configuration produced 100 hp at 1400 rpm for the OXX-6, a slight performance improvement over the earlier OX-5.

The museum obtained this historic "Jenny" from the John M. Larsen Collection in July 1978. It was one of the first aircraft to be acquired during the re-building years that followed the tragic arson fire of February 1978 - a fire that completely destroyed the museum's previous aircraft collection.

At one time, the museum's "Jenny" had been owned by Frank Tallman and Paul Mantz. Tallmantz Enterprises did almost all of the flying for the movies of the 1950s and 60s, and it was during this time that the museum's "Jenny" flew in the movie the *Spirit of St. Louis*. Charles Lindbergh is reported to have flown it during the filming.

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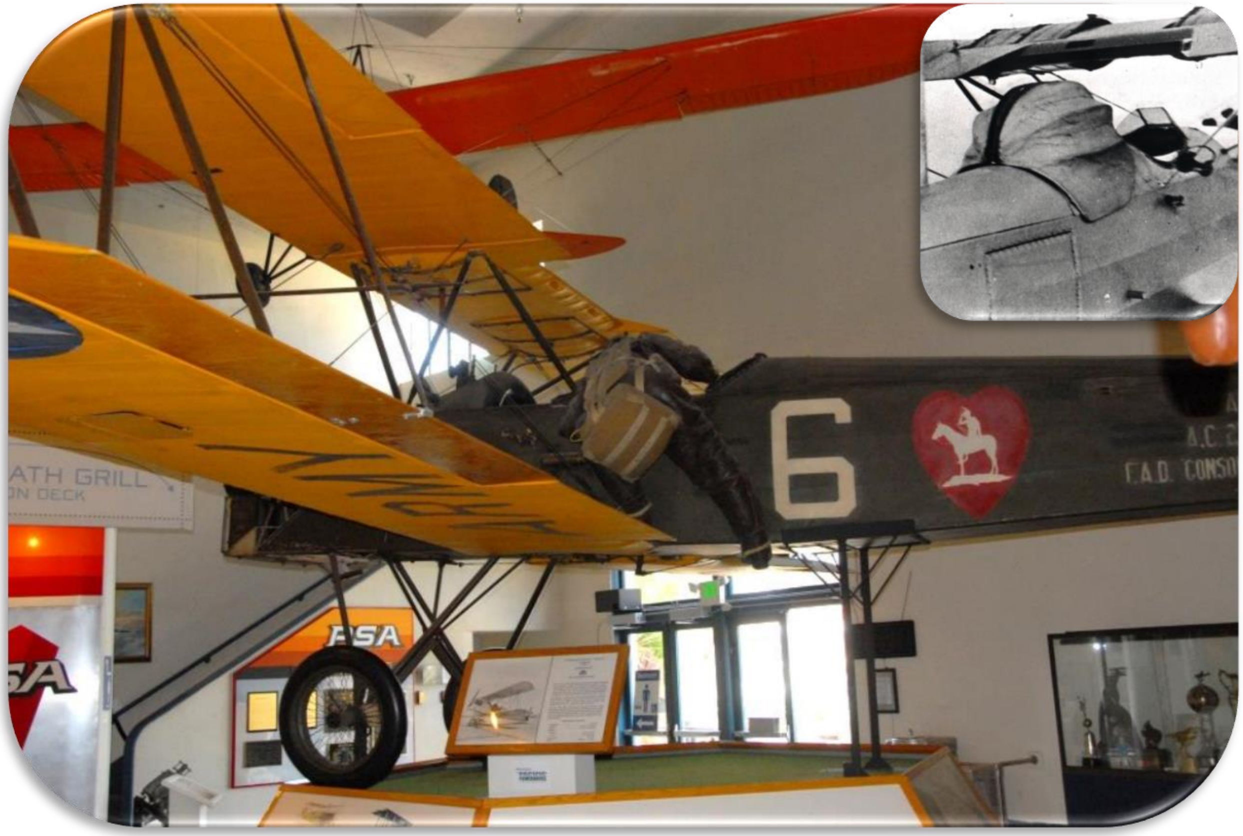
Golden Age Gallery



1st flight: 1923
(234 built)

Note: September 24, 1929, Lt. **James H. Doolittle** took off in a NY-2 (follow-on of the PT-1 **Trusty)**, under a hooded cockpit, (Mitchell Field, Long Island), flew 15 mile course and landed without seeing outside the airplane. **Considered the first instrument flight.**

Key Points: Consolidated PT-1 Trusty (**Original**) **1923, 1st production aircraft from Major Reuben Fleet's Consolidated Aircraft Corp**, of Buffalo, NY. Sep **1935, Consolidated moved to San Diego**. PT-1 (Primary Trainer) **replaced Curtiss Jenny fleet**. 180 hp Wright V-8. **August 16, 1928, first aircraft to land at new San Diego Airport, Lindbergh Field.**

This: Built in 1927, served the Army Air Corps from 1928 to 1932. Donated by the Atlas Hotels of San Diego. The Museum's PT-1 is **one of only three complete examples known to exist**.

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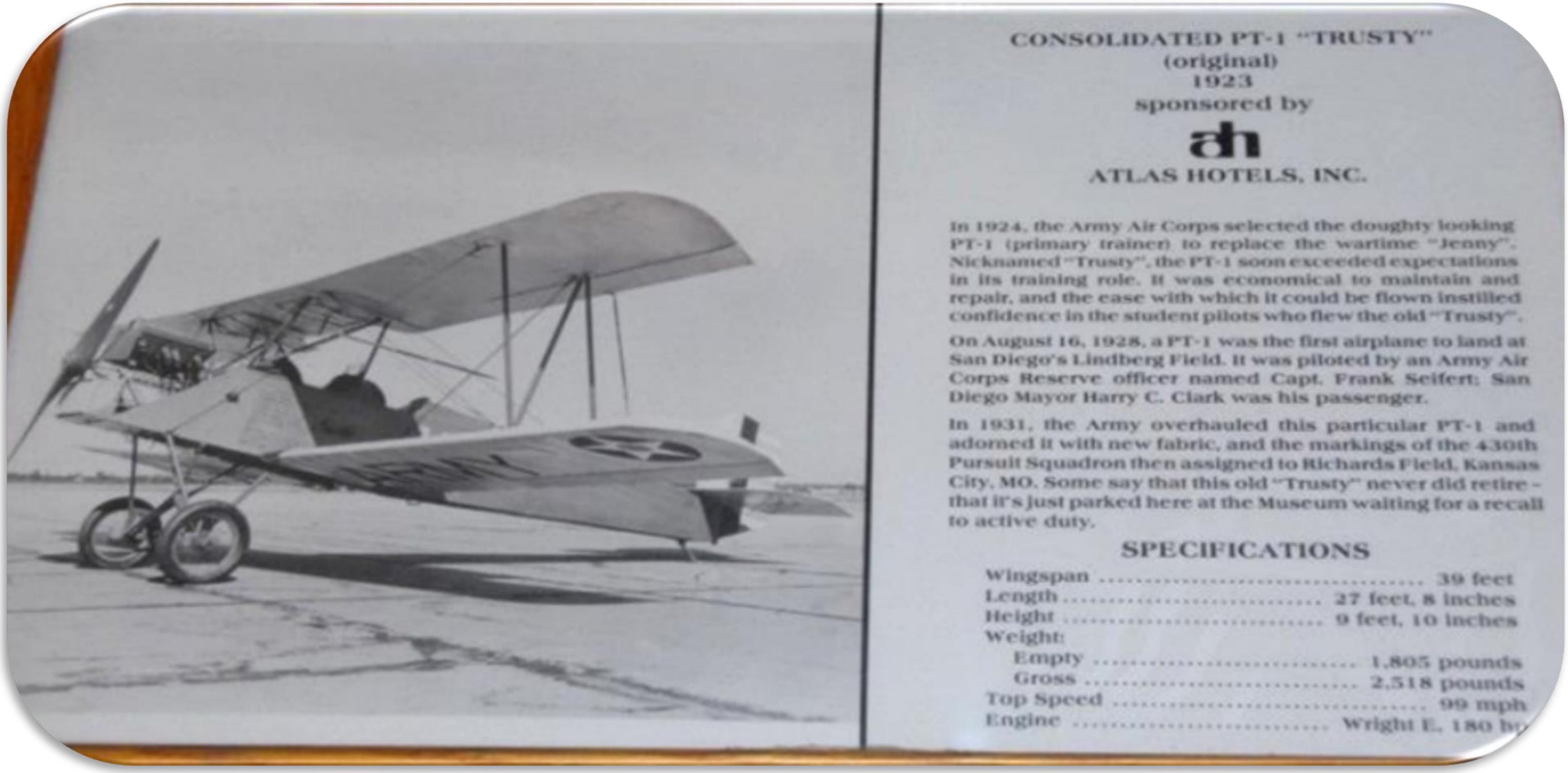

CONSOLIDATED PT-1 "TRUSTY"
(original)
1923
sponsored by
ah
ATLAS HOTELS, INC.

In 1924, the Army Air Corps selected the doughty looking PT-1 (primary trainer) to replace the wartime "Jenny". Nicknamed "Trusty", the PT-1 soon exceeded expectations in its training role. It was economical to maintain and repair, and the ease with which it could be flown instilled confidence in the student pilots who flew the old "Trusty".

On August 16, 1928, a PT-1 was the first airplane to land at San Diego's Lindberg Field. It was piloted by an Army Air Corps Reserve officer named Capt. Frank Seifert; San Diego Mayor Harry C. Clark was his passenger.

In 1931, the Army overhauled this particular PT-1 and adorned it with new fabric, and the markings of the 430th Pursuit Squadron then assigned to Richards Field, Kansas City, MO. Some say that this old "Trusty" never did retire – that it's just parked here at the Museum waiting for a recall to active duty.

SPECIFICATIONS

Wingspan	39 feet
Length	27 feet, 8 inches
Height	9 feet, 10 inches
Weight:	
Empty	1,805 pounds
Gross	2,518 pounds
Top Speed	99 mph
Engine	Wright E, 180 h

Extra Info: PT-1 had wooden wings, with a steel tube framed fuselage, tail, struts and landing gear, with a 180 hp Wright V-8 engine. A total of 230 were produced for the Army, as well as four for Siam (Thailand). The PT-1 quickly gained the **nickname Trusty because of the ease with which it could be flown**. Economical to maintain and repair and it was easy to fly.

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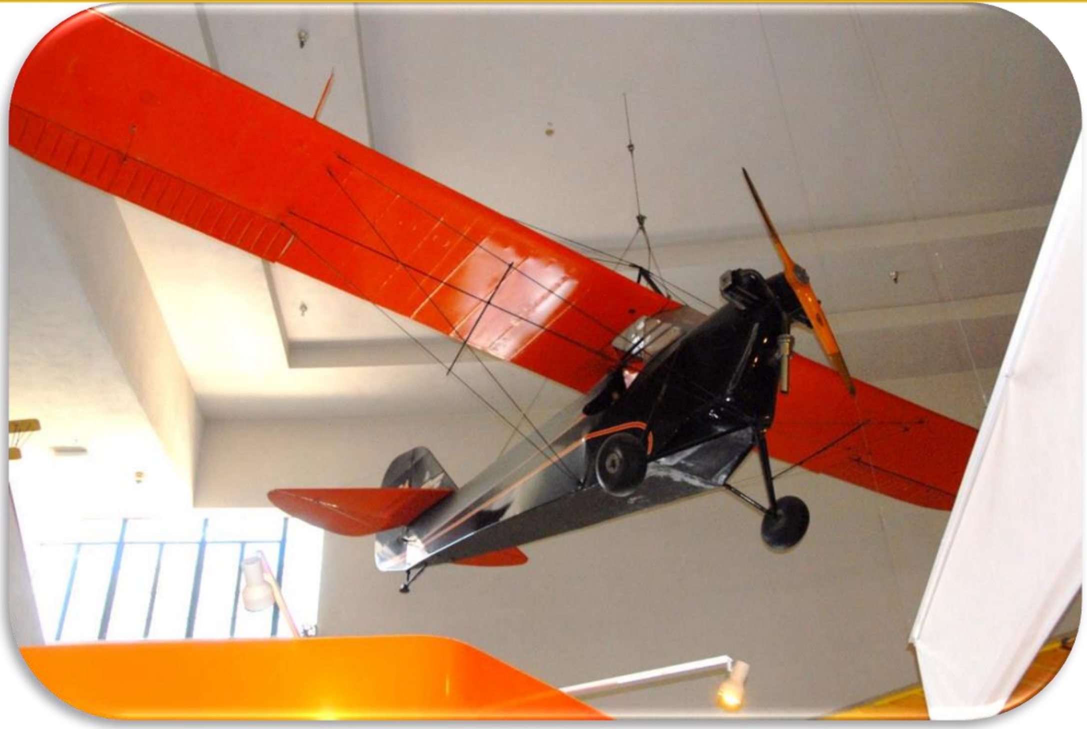

1st flight: 1931
(439 built)

Key Points: **Aeronca C-3 Collegian** (Original). Designed for **simple, low-cost fair weather flying fun**, the 1933 C-3's walrus-like appearance generated such nicknames as "Flying Bathtub" and "Airknocker", yet produced a mass of devoted owners who loved the ungainly appearance and sheer flying pleasure they offered at low expense. The Aeronca C-3 became **America's first truly light aircraft**. **36 hp air cooled engine, 484 lbs empty weight, 84 mph top speed and cost around $1500.**

This: A 1933 Aeronca C-3 Collegian, also known as the Razorback. The airframe has around 1200 hours, and the engine about fifty hours since last overhauled. Donated by Jim and Gwen Dewey of Santa Paula, California in 1983.

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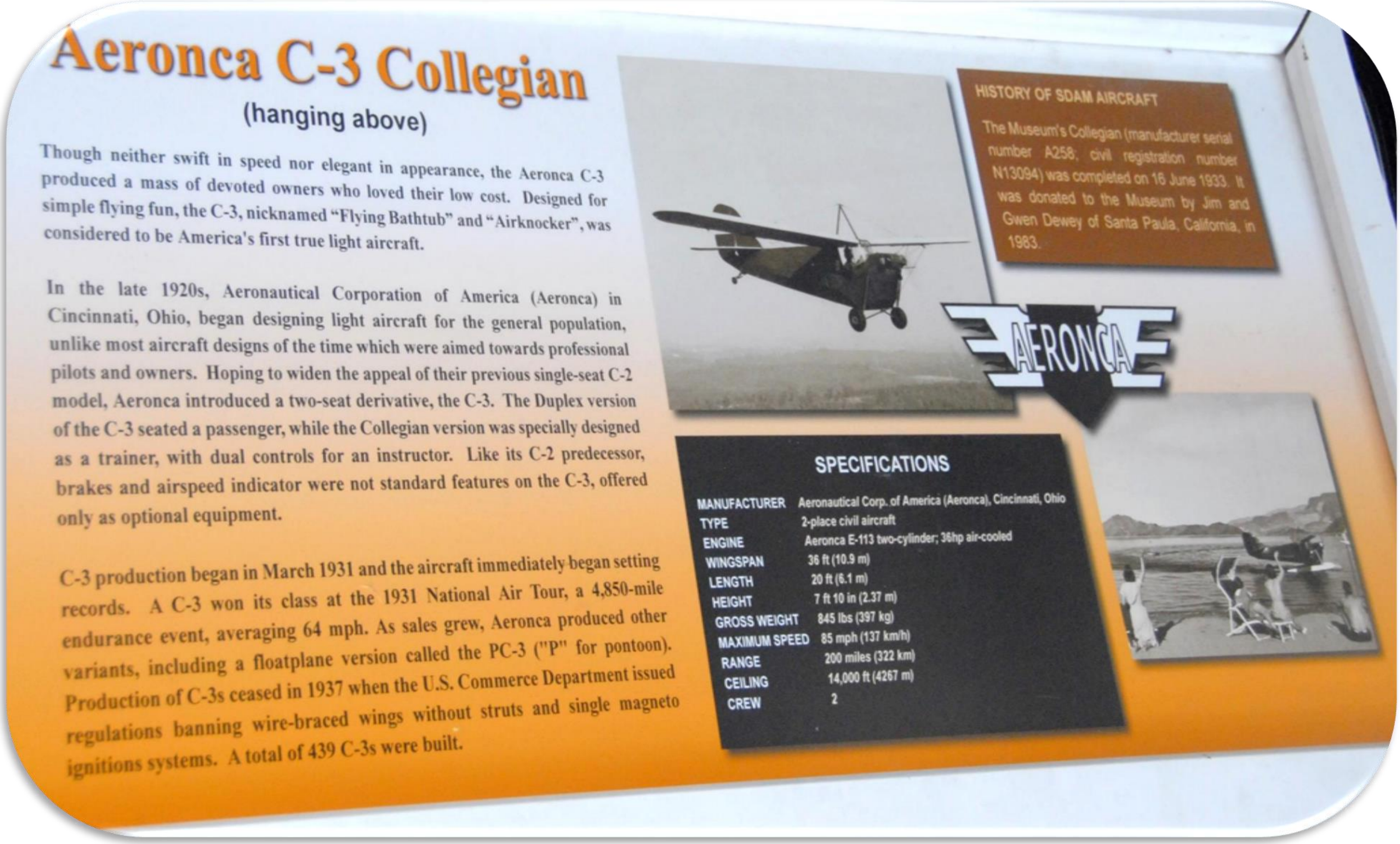


Aeronca C-3 Collegian

(hanging above)

Though neither swift in speed nor elegant in appearance, the Aeronca C-3 produced a mass of devoted owners who loved their low cost. Designed for simple flying fun, the C-3, nicknamed "Flying Bathtub" and "Airknocker", was considered to be America's first true light aircraft.

In the late 1920s, Aeronautical Corporation of America (Aeronca) in Cincinnati, Ohio, began designing light aircraft for the general population, unlike most aircraft designs of the time which were aimed towards professional pilots and owners. Hoping to widen the appeal of their previous single-seat C-2 model, Aeronca introduced a two-seat derivative, the C-3. The Duplex version of the C-3 seated a passenger, while the Collegian version was specially designed as a trainer, with dual controls for an instructor. Like its C-2 predecessor, brakes and airspeed indicator were not standard features on the C-3, offered only as optional equipment.

C-3 production began in March 1931 and the aircraft immediately began setting records. A C-3 won its class at the 1931 National Air Tour, a 4,850-mile endurance event, averaging 64 mph. As sales grew, Aeronca produced other variants, including a floatplane version called the PC-3 ("P" for pontoon). Production of C-3s ceased in 1937 when the U.S. Commerce Department issued regulations banning wire-braced wings without struts and single magneto ignitions systems. A total of 439 C-3s were built.

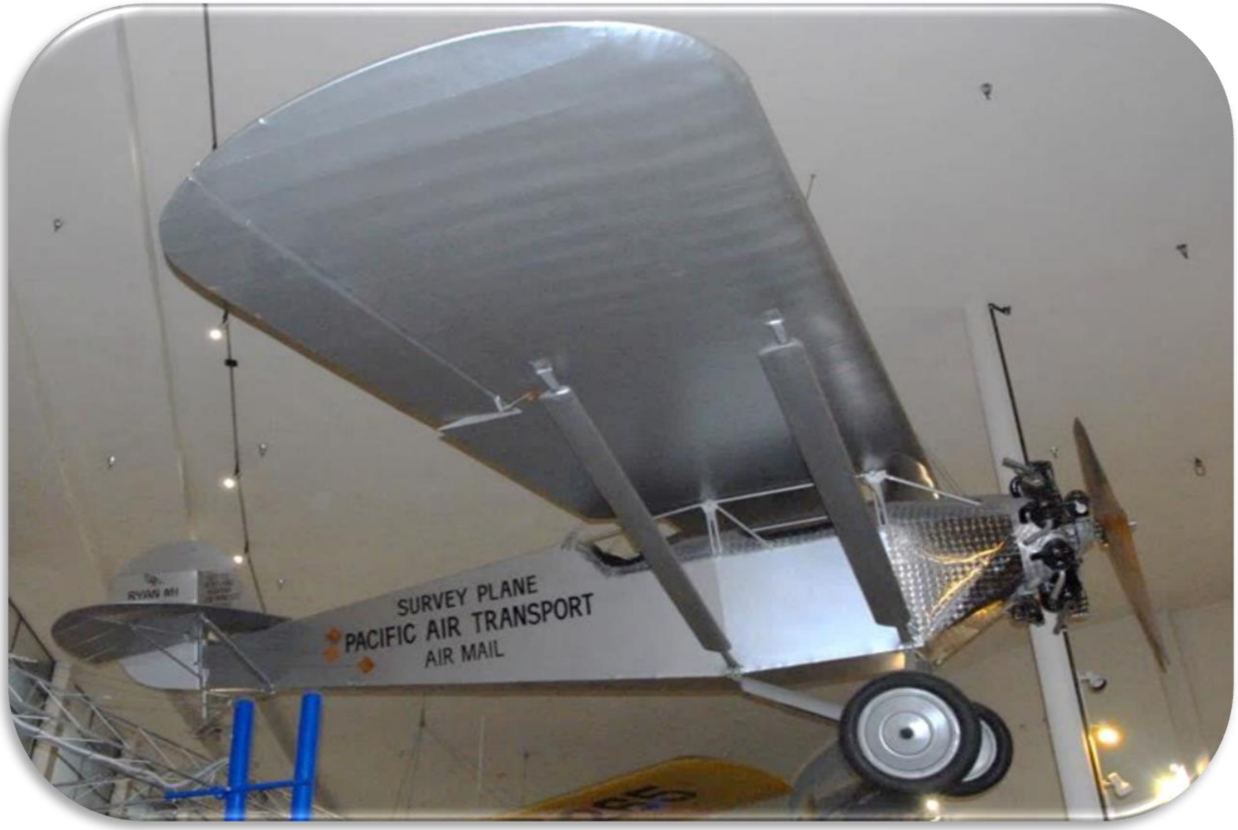
HISTORY OF SDAM AIRCRAFT

The Museum's Collegian (manufacturer serial number A258; civil registration number N13094) was completed on 16 June 1933. It was donated to the Museum by Jim and Gwen Dewey of Santa Paula, California, in 1983.

SPECIFICATIONS

MANUFACTURER	Aeronautical Corp. of America (Aeronca), Cincinnati, Ohio
TYPE	2-place civil aircraft
ENGINE	Aeronca E-113 two-cylinder; 36hp air-cooled
WINGSPAN	36 ft (10.9 m)
LENGTH	20 ft (6.1 m)
HEIGHT	7 ft 10 in (2.37 m)
GROSS WEIGHT	845 lbs (397 kg)
MAXIMUM SPEED	85 mph (137 km/h)
RANGE	200 miles (322 km)
CEILING	14,000 ft (4267 m)
CREW	2

Golden Age Gallery


RYAN M1
SURVEY PLANE
PACIFIC AIR TRANSPORT
AIR MAIL

1st flight: 1926
(36 built)

Key Points: **Ryan M-1** (Replica) In 1922, **T. Claude Ryan** (founder of Ryan Airlines), and **B.F. Mahoney**, shifted to manufacturing. **Feb, 1926, first M-1, built in San Diego**, very successful along with many mod's. **First successful monoplane build in US**. Engine: 200 hp 9 cylinder Wright J-4B Whirlwind radial. **Basis for Spirit of St Louis**.

This: Built in 1979 by SDASM volunteer craftsmen led by Harold Hawkins.

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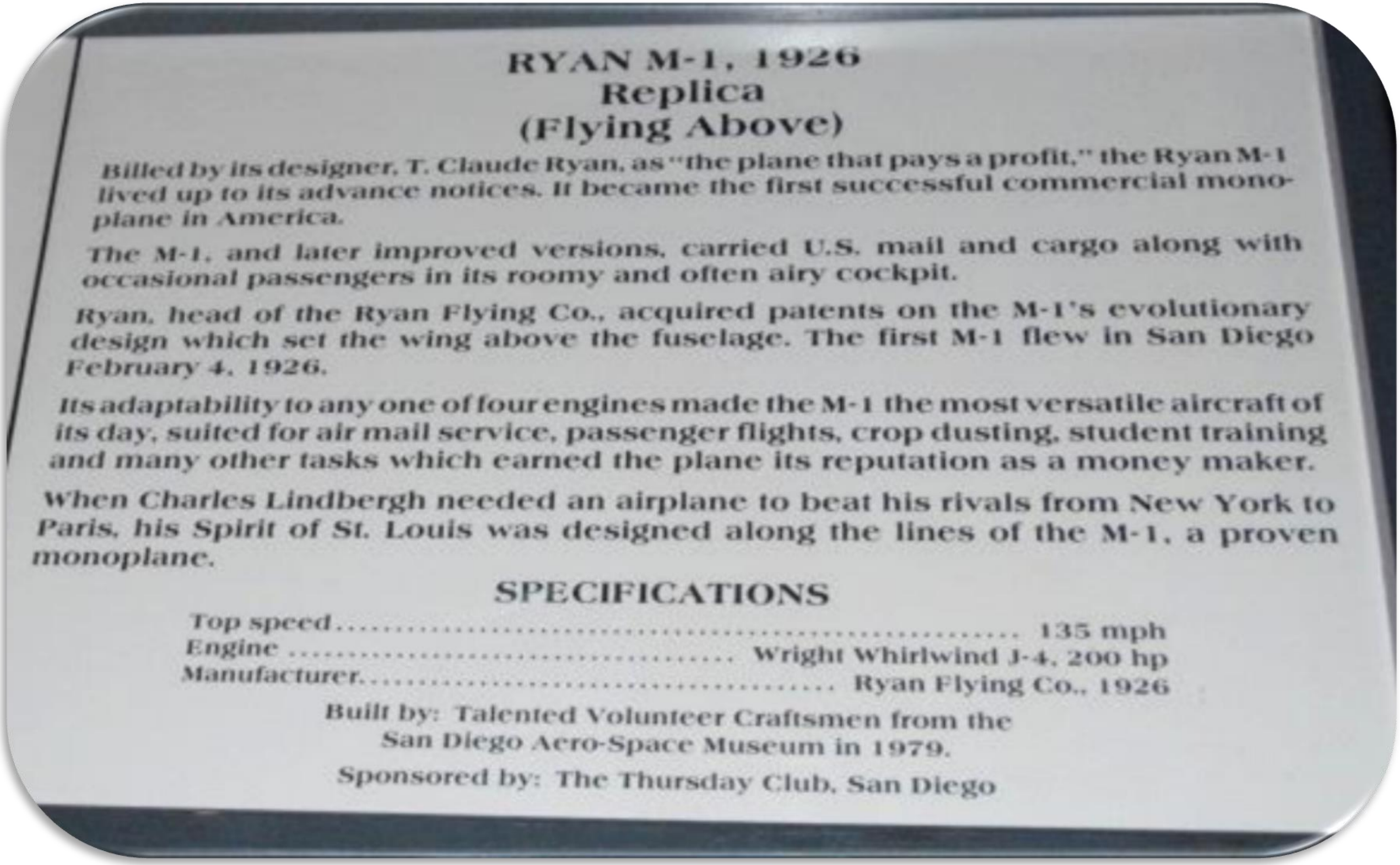

RYAN M-1, 1926
Replica
(Flying Above)

Billed by its designer, T. Claude Ryan, as "the plane that pays a profit," the Ryan M-1 lived up to its advance notices. It became the first successful commercial monoplane in America.

The M-1, and later improved versions, carried U.S. mail and cargo along with occasional passengers in its roomy and often airy cockpit.

Ryan, head of the Ryan Flying Co., acquired patents on the M-1's evolutionary design which set the wing above the fuselage. The first M-1 flew in San Diego February 4, 1926.

Its adaptability to any one of four engines made the M-1 the most versatile aircraft of its day, suited for air mail service, passenger flights, crop dusting, student training and many other tasks which earned the plane its reputation as a money maker.

When Charles Lindbergh needed an airplane to beat his rivals from New York to Paris, his Spirit of St. Louis was designed along the lines of the M-1, a proven monoplane.

SPECIFICATIONS

Top speed	135 mph
Engine	Wright Whirlwind J-4, 200 hp
Manufacturer	Ryan Flying Co., 1926

Built by: Talented Volunteer Craftsmen from the
San Diego Aero-Space Museum in 1979.

Sponsored by: The Thursday Club, San Diego

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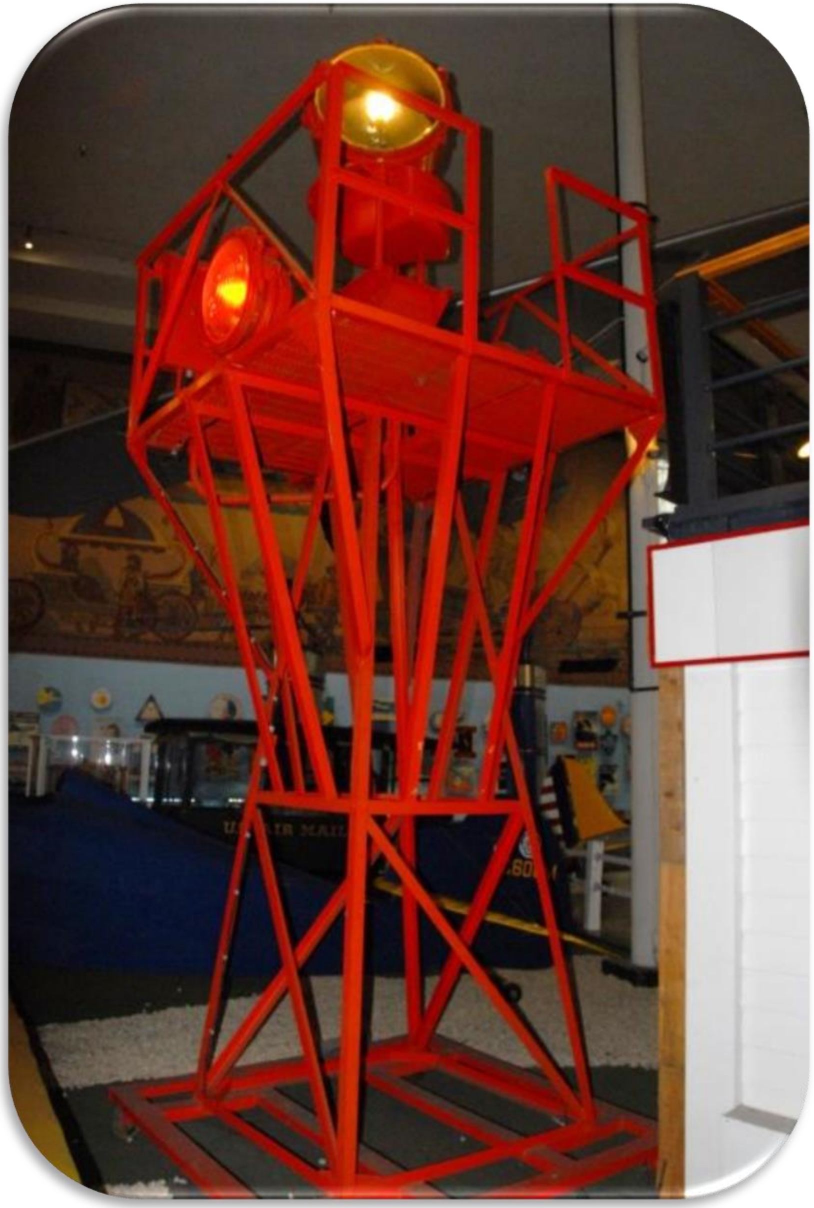

1st Used: 1926

Key Points: 1926, US needed a **navigation system for night airmail**. Solution: **Airway Beacons**. 1,000,000 CP, **seen @ 40 miles,** 2 beams w/coded light flashes. **At first, 10 mile intervals; later, 15 miles.**

1933, "Federal Airway System" had 18,000 miles of airways, **1550 beacons,** 263 lighted airfields. Beacons withdrawn in the 1950's in favor of radio navigation aids (NDB, VOR, LORAN, TACAN, GPS.

Each beacon was located on a **large concrete slab, in the shape of an arrow, to show the direction to the next beacon**.

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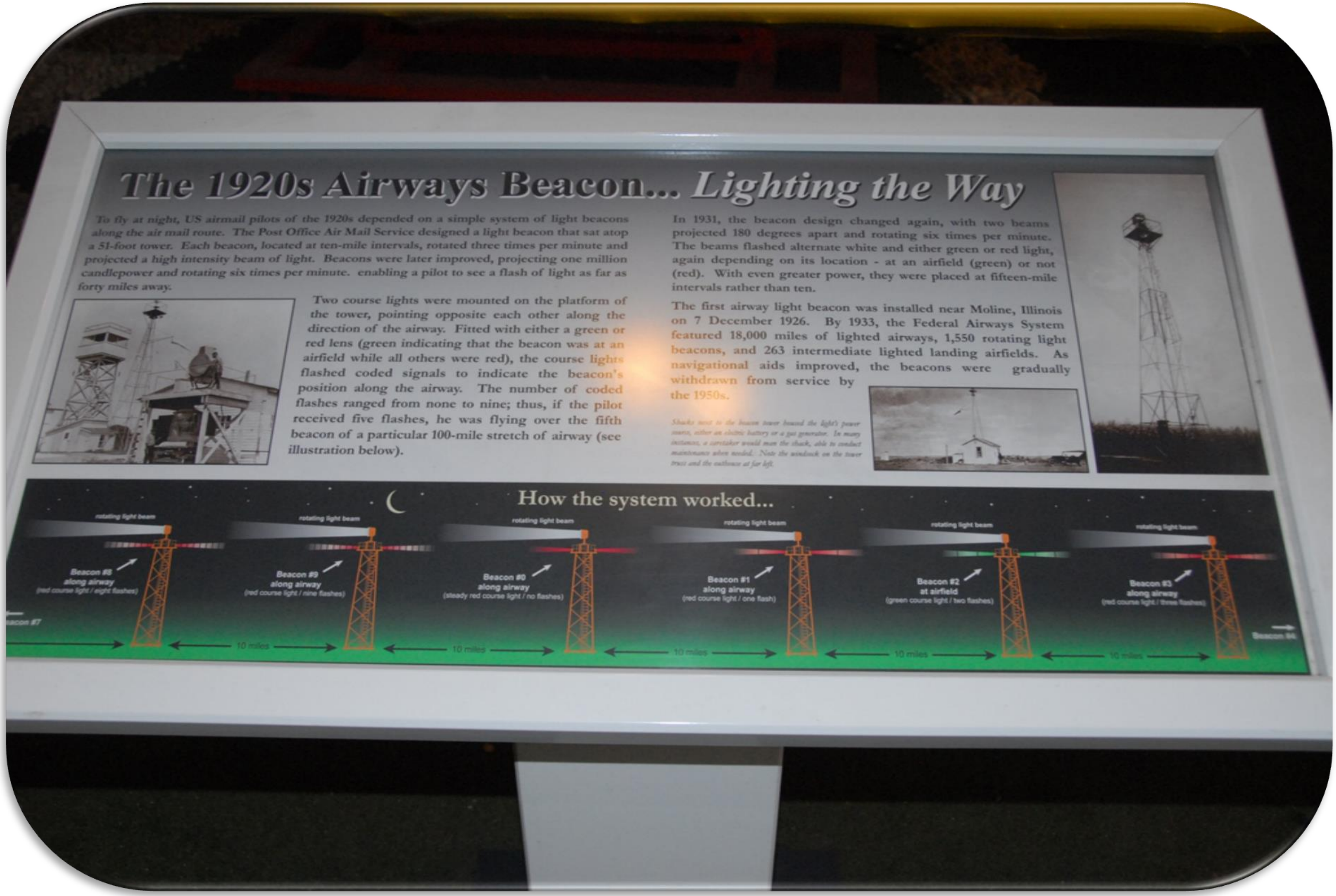

The 1920s Airways Beacon... *Lighting the Way*

To fly at night, US airmail pilots of the 1920s depended on a simple system of light beacons along the air mail route. The Post Office Air Mail Service designed a light beacon that sat atop a 51-foot tower. Each beacon, located at ten-mile intervals, rotated three times per minute and projected a high intensity beam of light. Beacons were later improved, projecting one million candlepower and rotating six times per minute. enabling a pilot to see a flash of light as far as forty miles away.

Two course lights were mounted on the platform of the tower, pointing opposite each other along the direction of the airway. Fitted with either a green or red lens (green indicating that the beacon was at an airfield while all others were red), the course lights flashed coded signals to indicate the beacon's position along the airway. The number of coded flashes ranged from none to nine; thus, if the pilot received five flashes, he was flying over the fifth beacon of a particular 100-mile stretch of airway (see illustration below).

In 1931, the beacon design changed again, with two beams projected 180 degrees apart and rotating six times per minute. The beams flashed alternate white and either green or red light, again depending on its location - at an airfield (green) or not (red). With even greater power, they were placed at fifteen-mile intervals rather than ten.

The first airway light beacon was installed near Moline, Illinois on 7 December 1926. By 1933, the Federal Airways System featured 18,000 miles of lighted airways, 1,550 rotating light beacons, and 263 intermediate lighted landing airfields. As navigational aids improved, the beacons were gradually withdrawn from service by the 1950s.

Shacks next to the beacon tower housed the light's power source, either an electric battery or a gas generator. In many instances, a caretaker would man the shack, able to conduct maintenance when needed. Note the windsock on the tower truss and the outhouse at far left.

How the system worked...

rotating light beam
Beacon #8
along airway
(red course light / eight flashes)
Beacon #9
along airway
(red course light / nine flashes)
Beacon #0
along airway
(steady red course light / no flashes)
Beacon #1
along airway
(red course light / one flash)
Beacon #2
at airfield
(green course light / two flashes)
Beacon #3
along airway
(red course light / three flashes)
Beacon #4
10 miles

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Golden Age Gallery

Reuben H. Fleet
Consolidated Aircraft

Key Points: **Major Reuben H. Fleet.** Born Mar 6, 1887, in Montesano, Washington. Died Oct 29, 1975. Teacher; realtor; **Army Aviator; Industrial entrepreneur**.

- **1918, began the U.S. Air Mail Service,**
- **1923, founded Consolidated Aircraft,**
- **1935, moved Consolidated to San Diego,**
- **1973, *Reuben H. Fleet Space Theatre built* & named in his honor.**

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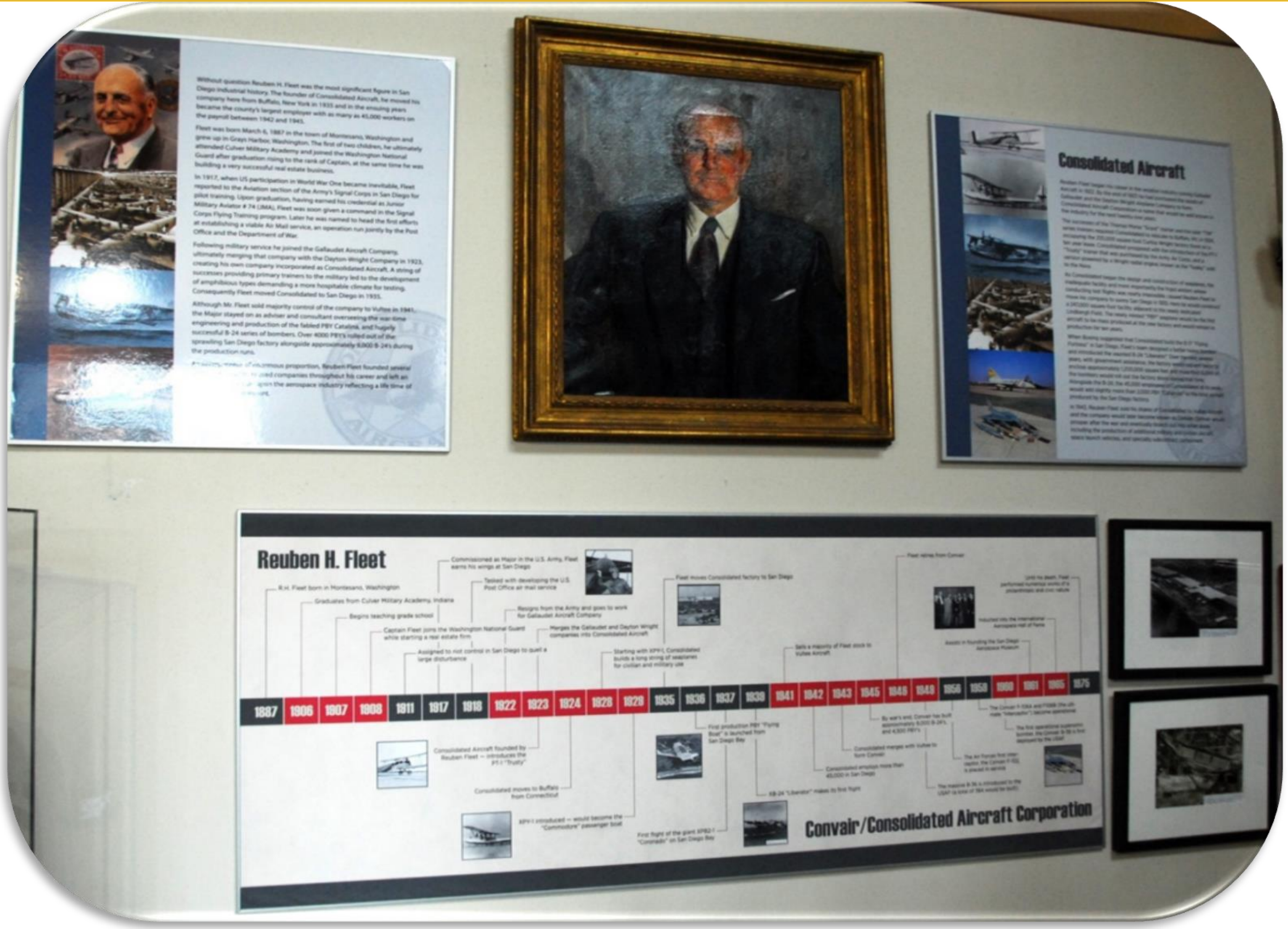
Golden Age Gallery



Without question Reuben H. Fleet was the most significant figure in San Diego industrial history. The founder of Consolidated Aircraft, he moved his company here from Buffalo, New York in 1935 and in the ensuing years became the county's largest employer with as many as 45,000 workers on the payroll between 1942 and 1945.

Fleet was born March 6, 1887 in the town of Montesano, Washington and grew up in Grays Harbor, Washington. The first of two children, he ultimately attended Culver Military Academy and joined the Washington National Guard after graduation rising to the rank of Captain, at the same time he was building a very successful real estate business.

In 1917, when US participation in World War One became inevitable, Fleet reported to the Aviation section of the Army's Signal Corps in San Diego for pilot training. Upon graduation, having earned his credential as Junior Military Aviator # 74 (JMA), Fleet was soon given a command in the Signal Corps Flying Training program. Later he was named to head the first efforts at establishing a viable Air Mail service, an operation run jointly by the Post Office and the Department of War.

Following military service he joined the Gallaudet Aircraft Company, ultimately merging that company with the Dayton-Wright Company in 1923, creating his own company incorporated as Consolidated Aircraft. A string of successes providing primary trainers to the military led to the development of amphibious types demanding a more hospitable climate for testing. Consequently Fleet moved Consolidated to San Diego in 1935.

Although Mr. Fleet sold majority control of the company to Vultee in 1941, the Major stayed on as adviser and consultant overseeing the war-time engineering and production of the fabled PBY Catalina, and hugely successful B-24 series of bombers. Over 4000 PBY's rolled out of the sprawling San Diego factory alongside approximately 6,000 B-24's during the production runs.

[illegible] of voluminous proportion, Reuben Fleet founded several [illegible] companies throughout his career and left an [illegible] upon the aerospace industry reflecting a life time of [illegible].

Key Points: **Major Reuben H. Fleet.** Many historians agree that Fleet was one of the most significant figures in San Diego's industrial history.

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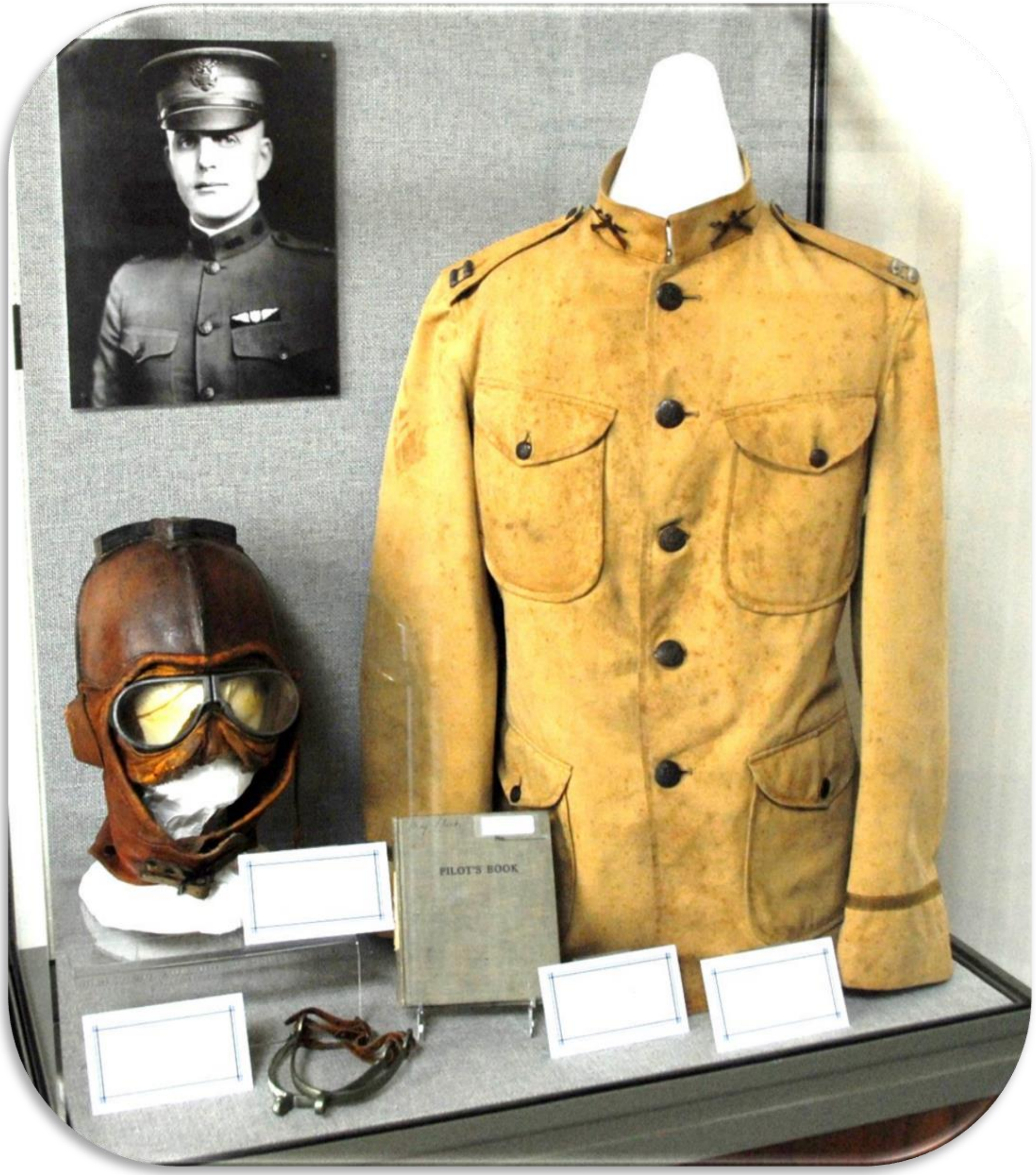
Golden Age Gallery



Key Points: **Major Reuben H. Fleet's flying gear**. While in the Army Air Service, Fleet Commanded the 18th Aero Squadron (Training); 1918, set up **first air mail service** (Wash DC – New York). World War I, XO for Army Air Service Flight Training, in Wash DC. First Officer-In-Charge of **Aerial Mail Service; Army Air Service Chief Contracting Officer** (Received Distinguished Service Medal).

Note: **Fleet's Son, Preston "Sandy" Fleet, was 1st President of SDASM.**

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Consolidated Aircraft Corporation

(Later; Convair, General Dynamics, McDonnell Douglas)

Key Points: **Consolidated Aircraft Corporation** was **founded in 1923** by **Reuben H. Fleet** in Buffalo, NY.
1928, **Lawrence D Bell** (later founder of Bell Aircraft) became Vice Pres. & General Manager).
1935, Consolidated moved across the country to **San Diego, California**.
1936, **PBY Catalina** first launched in **San Diego Bay** (**Over 4000 built**).
1939, **B-24 Liberator** prototype first flight in December (**19,256 built**).
1941, Consolidated was San Diego's largest employer with **25,000 employees**, which eventually expanded to **41,000** (or 45,000) reports vary, by the following year. **40% were women**.
1941, Fleet sold his interest in Consolidated to AVCO's **Vultee** subsidiary.
1943, Consolidated merged w/Vultee Aircraft to form **Consolidated-Vultee Aircraft**, later known as **Convair** and **officially became Convair in 1954**.
1953, Convair became a Division of **General Dynamics**.
1994, McDonnell Douglas/Hughes/Lockheed-Martin purchased sections/portions of Convair Division from General Dynamics. Convair deactivated in 1996.

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Golden Age Gallery

Extra Info: As Consolidated Aircraft Corp:

- **PT-1 Trusty** (1923);
- **PT-3** trainer (1927);
- **PT-11** (1931);
- **P-30** (1934);
- **PBY Catalina** (1936);
- **PB2Y Coronado** (1937);
- **B-24 Liberator** (1939);
- **TBY Sea Wolf** (1941);
- **PB4Y-1 Liberator**;
- **C-87 Liberator Express**;
- **PB4Y-1 & 2** (1944);
- **B-32 Dominator** (1942).

As Convair:

- **B-36 bomber**;
- **F-102 Delta Dagger**;
- **F-106 Delta Dart**;
- **B-58 Hustler bomber**;
- **240 thru 990** jet airliners;
- **Atlas rockets**
- **Space Shuttle fuselage**.

*(Red = >500 built)

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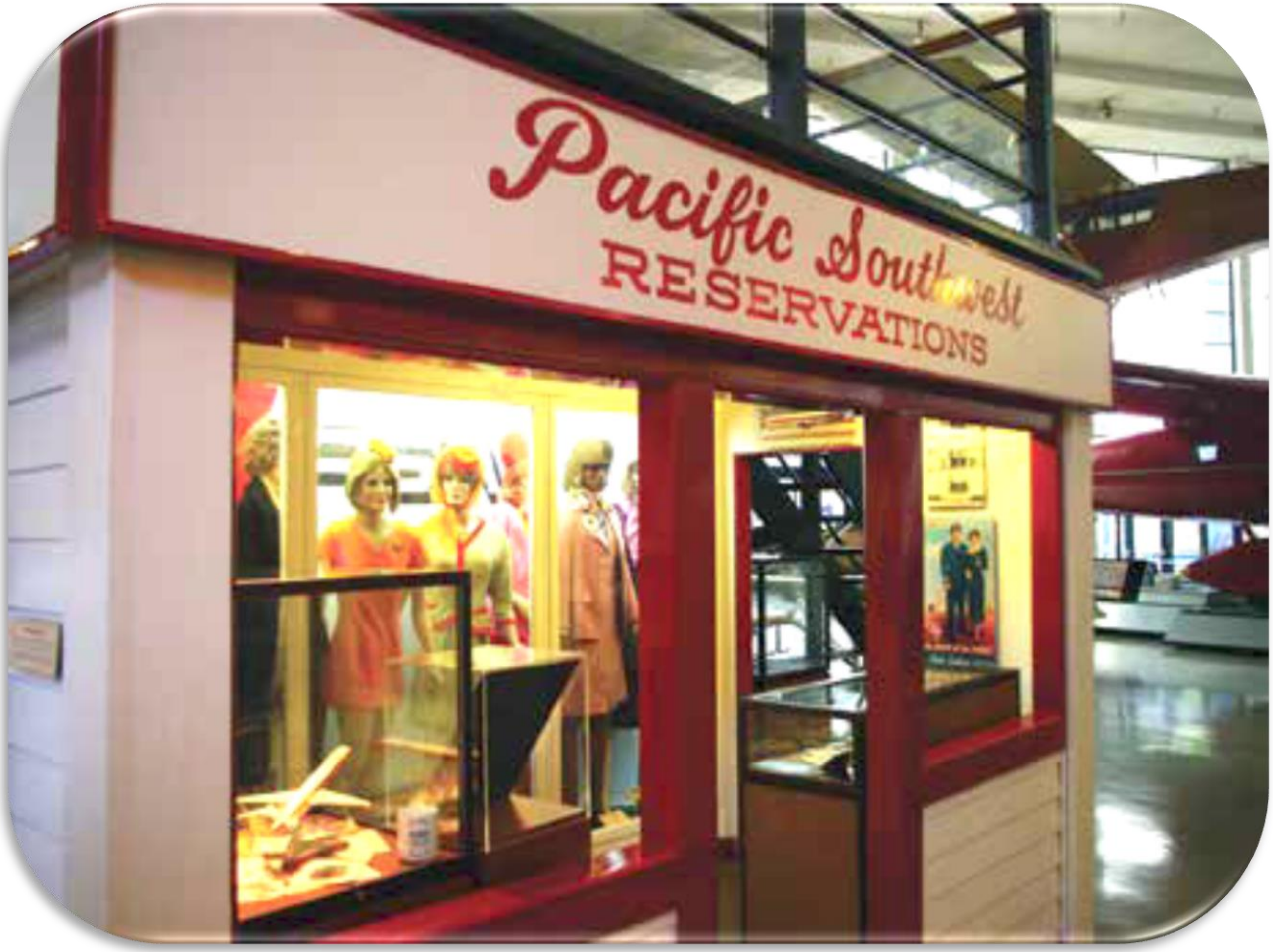

Extra Info: The building in the Museum is a reproduction of the **first PSA reservations hut used at Lindbergh Field**. It originally was a restroom facility at MCRD and "repurposed" by PSA employees.

Key Points: **Kenny Friedkin, founded PSA in San Diego, on May 6, 1949**, with a leased **DC-3** providing service from San Diego to Oakland, CA. In addition to the DC-3s, ultimately PSA flew **DC-4s, L-188s, BAE-146s, B-727s and DC-9s** servicing **California, Nevada, Utah, Arizona, Oregon, Washington State and Mexico**. Against stiff competition, PSA was sold to **US Airways** and the **last PSA flight** took off on April 8, **1988**.

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Golden Age Gallery

aking Flight
The 1950s
The "Poor Sailors" Airline
The 1940s
PSA

Extra Info: Many items of PSA memorabilia have been donated by the PSA "Family". Kenny Friedkin named the carrier **Pacific Southwest Airline** (PSA) but because so many navy men from San Diego flew on it and because the tickets were inexpensive, it soon gained the nickname "**P**oor **S**ailor's **A**irline". From the start, PSA's business **model was to offer low fares and quality service**, indeed, there first advertising slogan was "**the World's Friendliest Airline.**" This model caught on, and soon PSA attracted more passengers than just sailors.

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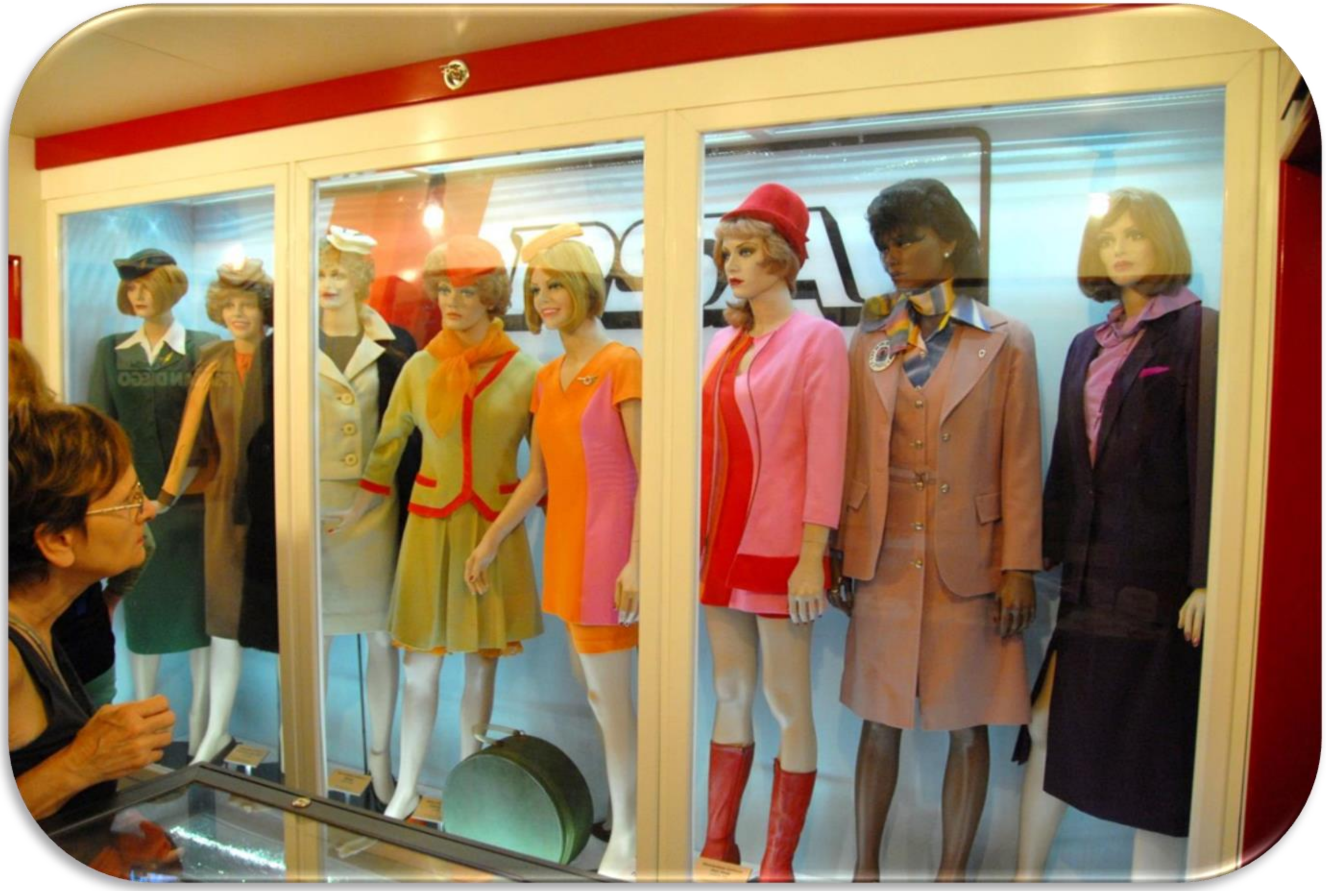

Extra Info: In the mid 1950s, PSA started to earn the reputation for only hiring single, **attractive stewardesses**. Some even argue that the most important introduction PSA made in the 1960s was the unveiling of the **fist miniskirt stewardess uniform in 1966**!

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Golden Age Gallery

PSA
GONE BUT NOT FORGOTTEN
PSA FLIGHT 1771
PSA FLIGHT 182
IN MEMORY
SEPTEMBER 25, 1978
Flight #182

Key Points: PSA's memorial honoring **Flight 1771** & **Flight 182**.

Flight 182 - On Sep 25, **1978**, a Cessna 172 collided with PSA flight 182, B-727, over San Diego, killing 144 people on the ground and in the air. 37 of the fatalities were PSA employees.

Flight 1771, BAE-146, on Dec 7, **1987**, a hijacker killed the flight crew causing the aircraft to crash killing all 43 passengers and crew.

As a result of these two crashes, the FAA increased **ATC minimum aircraft approach and enroute separation**, increased **security for cockpit doors**, modified airline "**terminated employee**" regulations, and tightened **cockpit access policies**.

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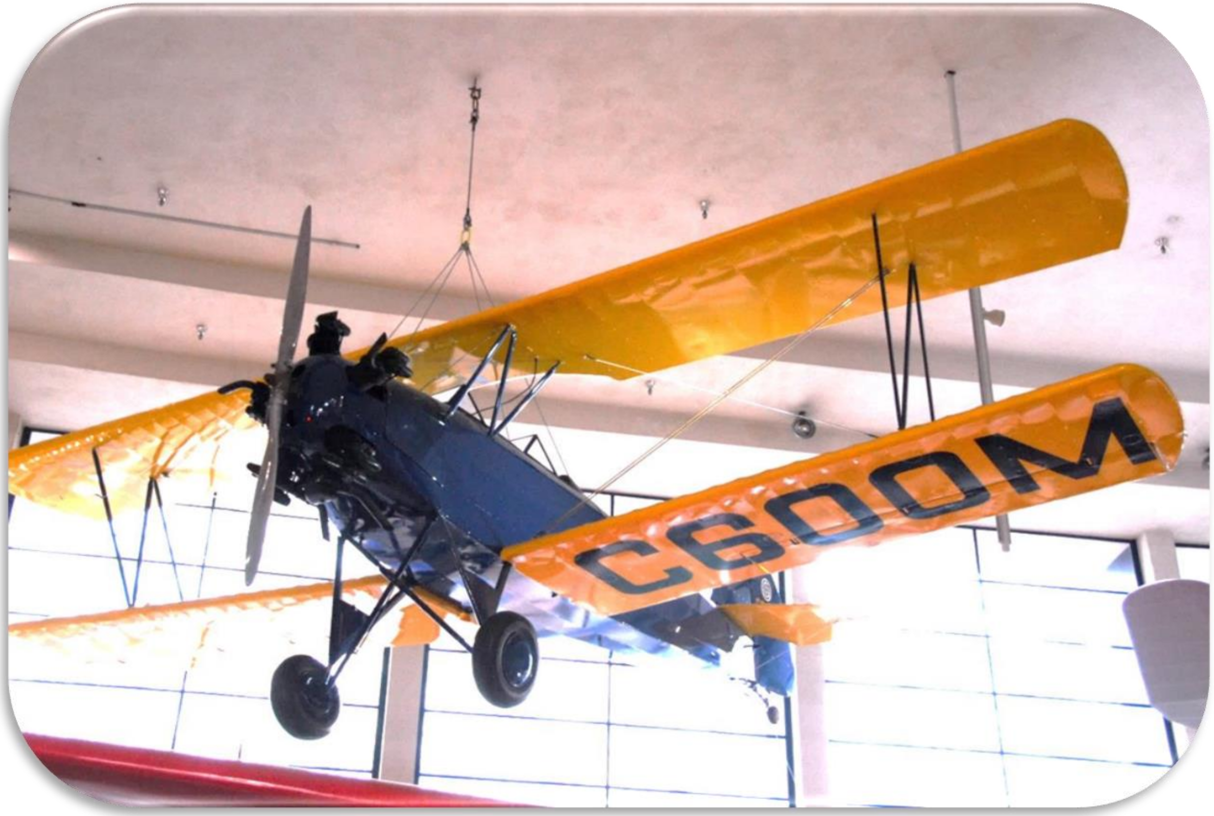

1st flight: 1928
(229 to 350 built, reports vary)

Key Points: Fleet Model 2 (Original) Named for **Major Reuben H. Fleet**, founder, owner and guiding hand at **Consolidated Aircraft**. In 1928, the Fleet line of aircraft was developed. **Designed for civilian sport flying, fully Aerobatic.** 100 hp, 5 cylinder, Kinner, K5 radial. **1930, Paul Mantz performed 46 outside loops.**

This: Built **1929**, by Fleet Aircraft Inc. Donated in 1978 by **Preston "Sandy" Fleet** of San Diego, son of Major Fleet, and **first president of the San Diego Aerospace Museum**.

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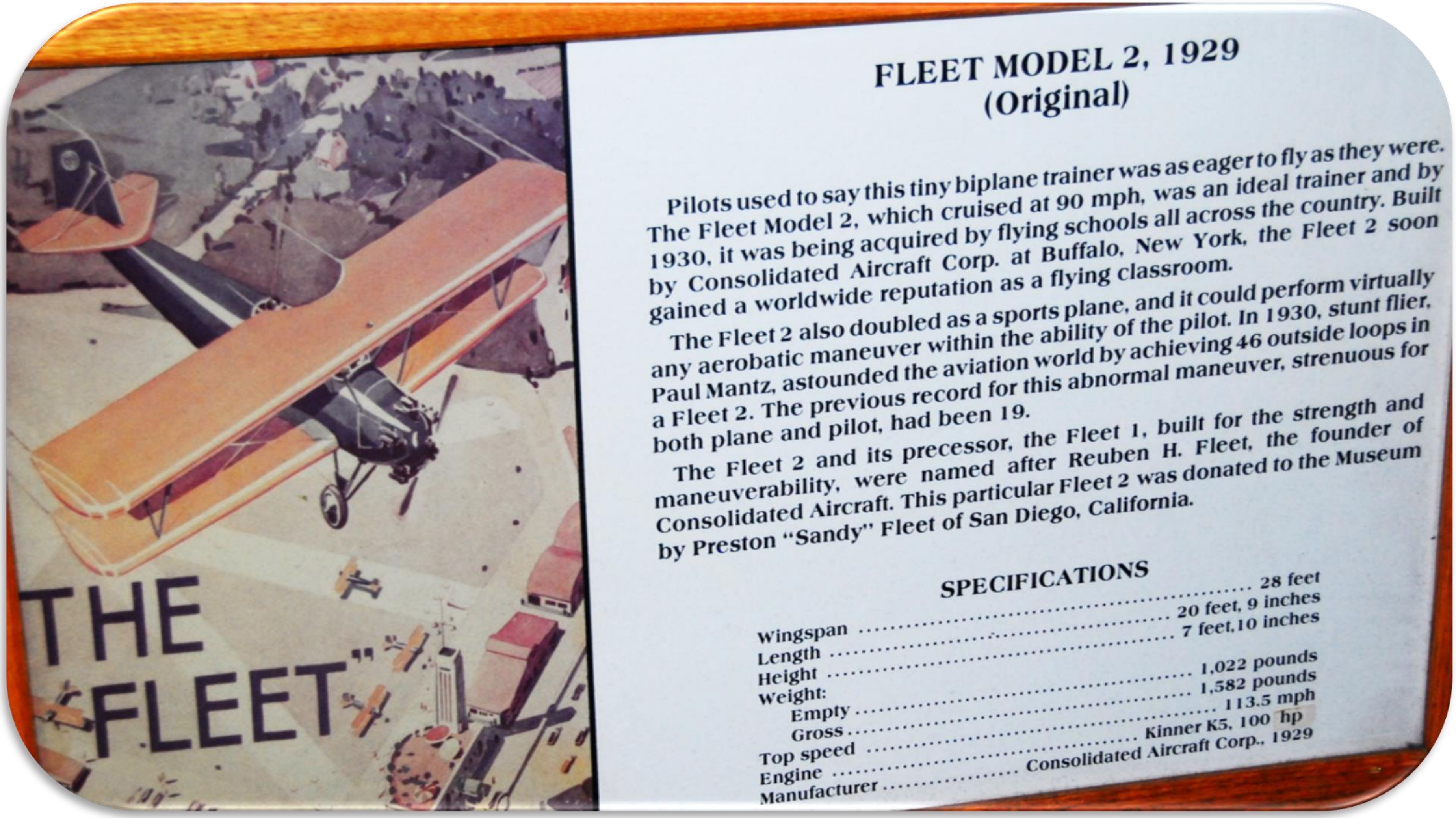


FLEET MODEL 2, 1929
(Original)

Pilots used to say this tiny biplane trainer was as eager to fly as they were. The Fleet Model 2, which cruised at 90 mph, was an ideal trainer and by 1930, it was being acquired by flying schools all across the country. Built by Consolidated Aircraft Corp. at Buffalo, New York, the Fleet 2 soon gained a worldwide reputation as a flying classroom.

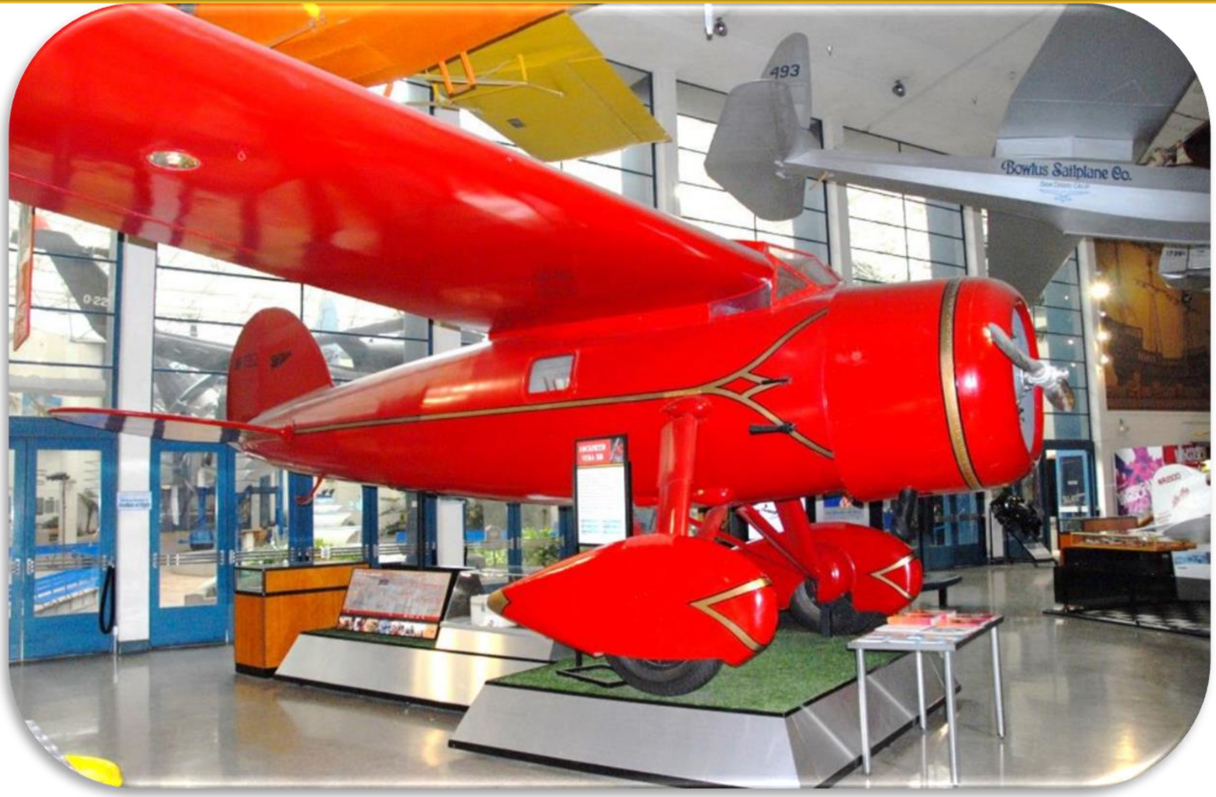
The Fleet 2 also doubled as a sports plane, and it could perform virtually any aerobatic maneuver within the ability of the pilot. In 1930, stunt flier, Paul Mantz, astounded the aviation world by achieving 46 outside loops in a Fleet 2. The previous record for this abnormal maneuver, strenuous for both plane and pilot, had been 19.

The Fleet 2 and its precessor, the Fleet 1, built for the strength and maneuverability, were named after Reuben H. Fleet, the founder of Consolidated Aircraft. This particular Fleet 2 was donated to the Museum by Preston "Sandy" Fleet of San Diego, California.

SPECIFICATIONS

Wingspan	28 feet
Length	20 feet, 9 inches
Height	7 feet,10 inches
Weight:	
Empty	1,022 pounds
Gross	1,582 pounds
Top speed	113.5 mph
Engine	Kinner K5, 100 hp
Manufacturer	Consolidated Aircraft Corp., 1929

Golden Age Gallery



1st flight: 1927
(180 built)

Key Points: **Lockheed Vega 5B** (Model). High speed passenger monoplane. First delivered in 1927, model 5B had 450 hp Pratt & Whitney R-1340 Wasp engine. **1929, Amelia Earhart** placed third in the **Women's Cross Country Air Race** (Powder Puff Derby) in a Vega and in 1932 she flew a Vega **solo across the Atlantic** and then **solo across the US.** Earhart set several women's speed and distance records with her Vega. Vega model 5B was a 7 passenger variant.

This: Full scale model, built for motion picture ***Amelia***, starring Hillary Swank. This model was donated by Avalon Pictures in 2010.

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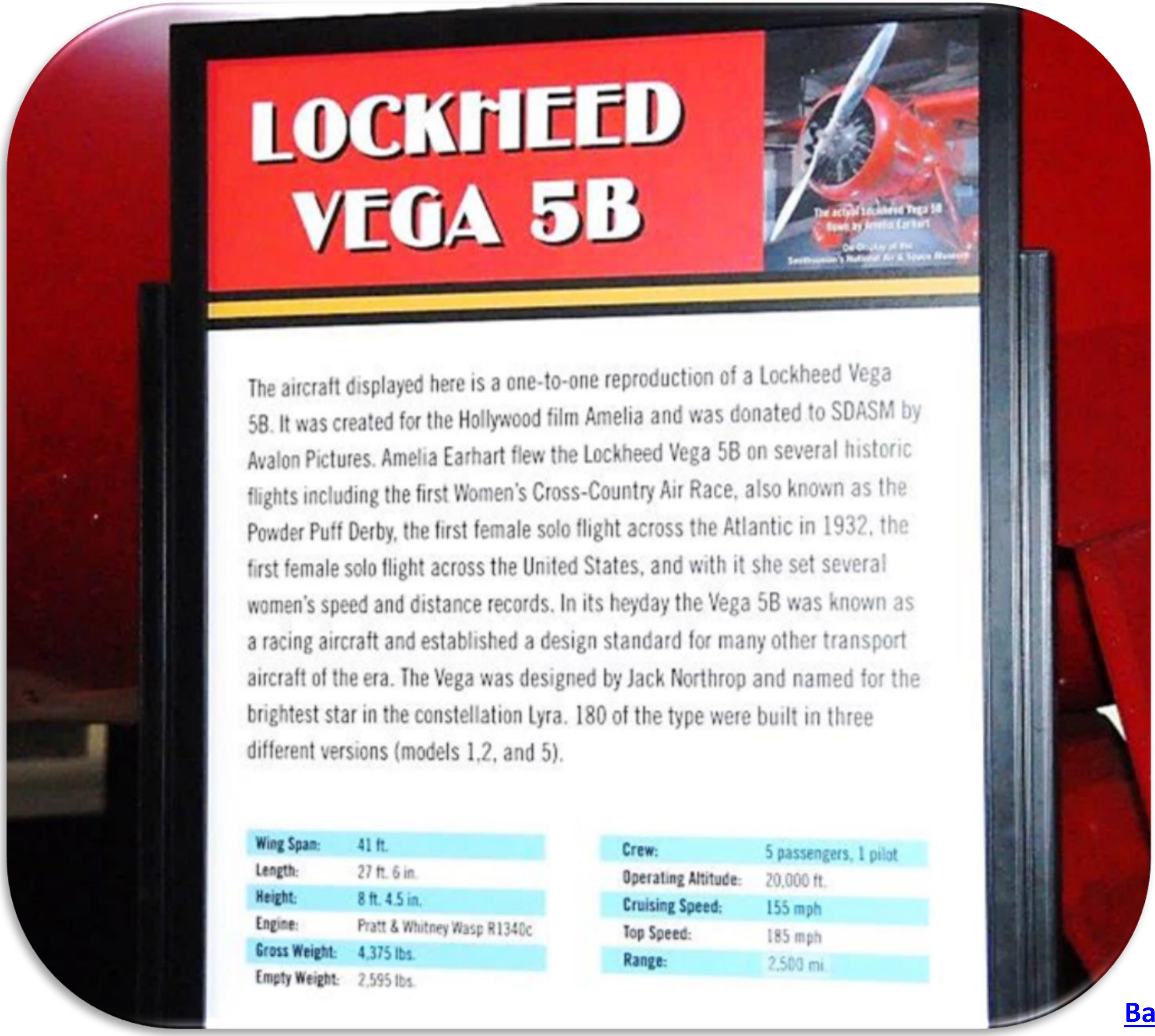

LOCKHEED VEGA 5B

The actual Lockheed Vega 5B flown by Amelia Earhart
On Display at the Smithsonian's National Air & Space Museum

The aircraft displayed here is a one-to-one reproduction of a Lockheed Vega 5B. It was created for the Hollywood film Amelia and was donated to SDASM by Avalon Pictures. Amelia Earhart flew the Lockheed Vega 5B on several historic flights including the first Women's Cross-Country Air Race, also known as the Powder Puff Derby, the first female solo flight across the Atlantic in 1932, the first female solo flight across the United States, and with it she set several women's speed and distance records. In its heyday the Vega 5B was known as a racing aircraft and established a design standard for many other transport aircraft of the era. The Vega was designed by Jack Northrop and named for the brightest star in the constellation Lyra. 180 of the type were built in three different versions (models 1,2, and 5).

Wing Span:	41 ft.
Length:	27 ft. 6 in.
Height:	8 ft. 4.5 in.
Engine:	Pratt & Whitney Wasp R1340c
Gross Weight:	4,375 lbs.
Empty Weight:	2,595 lbs.

Crew:	5 passengers, 1 pilot
Operating Altitude:	20,000 ft.
Cruising Speed:	155 mph
Top Speed:	185 mph
Range:	2,500 mi.

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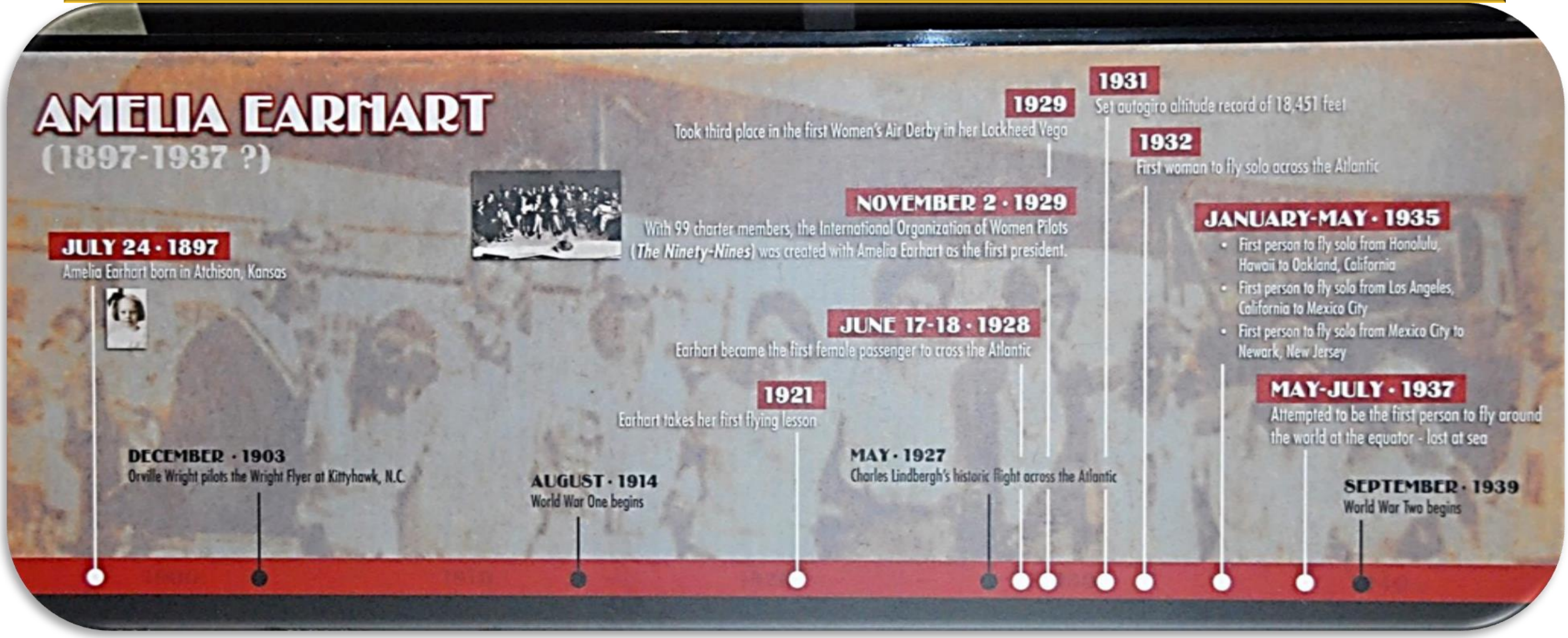

AMELIA EARHART

(1897-1937 ?)

JULY 24 · 1897
Amelia Earhart born in Atchison, Kansas

DECEMBER · 1903
Orville Wright pilots the Wright Flyer at Kittyhawk, N.C.

AUGUST · 1914
World War One begins

1921
Earhart takes her first flying lesson

MAY · 1927
Charles Lindbergh's historic flight across the Atlantic

JUNE 17-18 · 1928
Earhart became the first female passenger to cross the Atlantic

NOVEMBER 2 · 1929
With 99 charter members, the International Organization of Women Pilots (*The Ninety-Nines*) was created with Amelia Earhart as the first president.

1929
Took third place in the first Women's Air Derby in her Lockheed Vega

1931
Set autogiro altitude record of 18,451 feet

1932
First woman to fly solo across the Atlantic

JANUARY-MAY · 1935
- First person to fly solo from Honolulu, Hawaii to Oakland, California
- First person to fly solo from Los Angeles, California to Mexico City
- First person to fly solo from Mexico City to Newark, New Jersey

MAY-JULY · 1937
Attempted to be the first person to fly around the world at the equator - lost at sea

SEPTEMBER · 1939
World War Two begins

Key Points: **Amelia Earhart** (1897 – 1937?)

1921 - Amelia takes **first flying lesson**.

1928 - First female passenger to **cross the Atlantic**.

1929 **-** Amelia placed third in the **Women's Cross Country Air Race** (Powder Puff Derby).

1929 - First **President** International Organization of Women Pilots (**The Ninety-Nines**).

1932 - **First woman to fly solo across the Atlantic.**

1935 - **First person solo Hawaii to LA, LA to Mexico City, Mexico City to Newark.**

1937 - **Attempted first person around the world at equator.**
Lost at sea.

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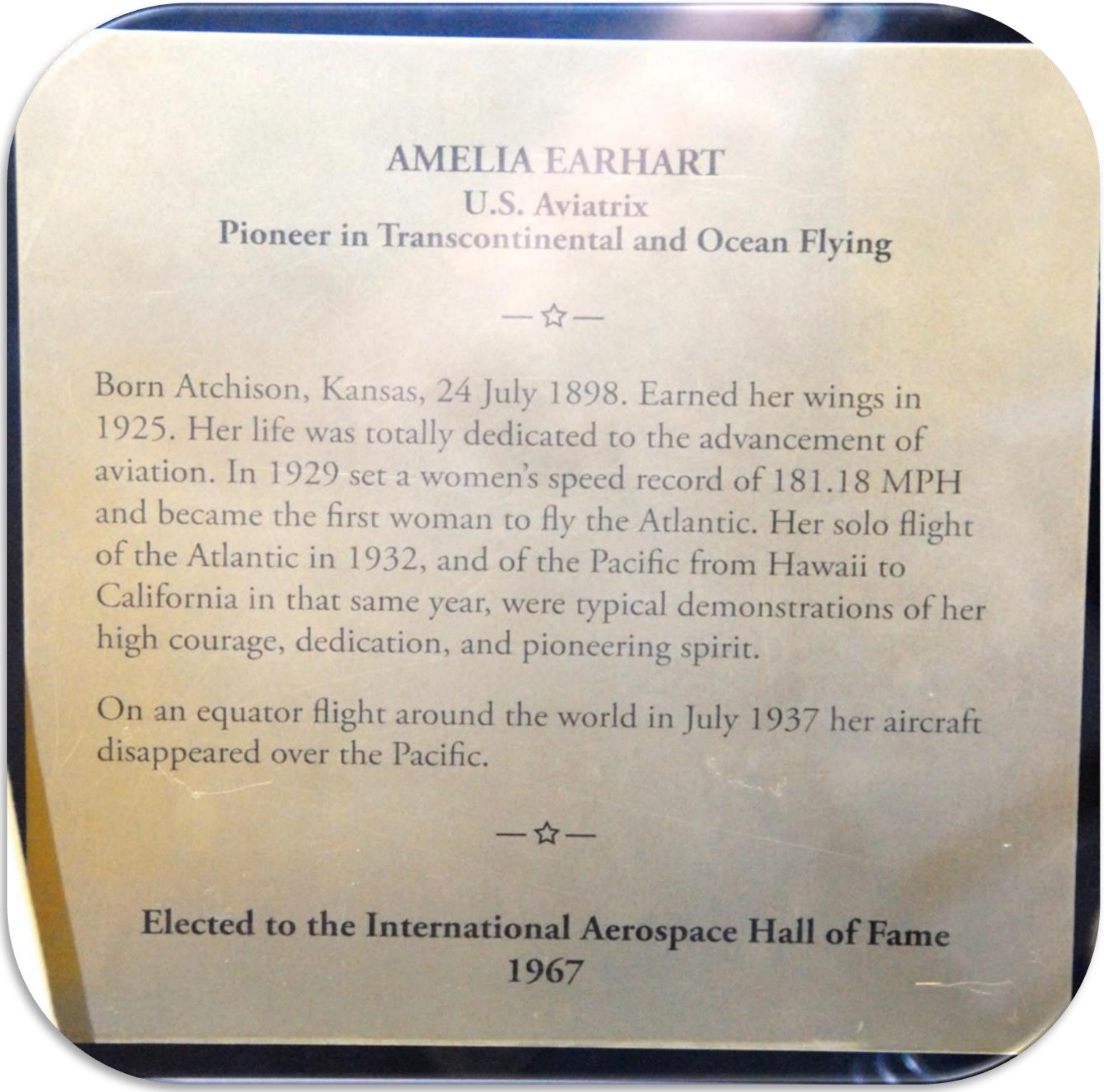

AMELIA EARHART
U.S. Aviatrix
Pioneer in Transcontinental and Ocean Flying

* * *

Born Atchison, Kansas, 24 July 1898. Earned her wings in 1925. Her life was totally dedicated to the advancement of aviation. In 1929 set a women's speed record of 181.18 MPH and became the first woman to fly the Atlantic. Her solo flight of the Atlantic in 1932, and of the Pacific from Hawaii to California in that same year, were typical demonstrations of her high courage, dedication, and pioneering spirit.

On an equator flight around the world in July 1937 her aircraft disappeared over the Pacific.

* * *

Elected to the International Aerospace Hall of Fame
1967

Key Points:

Amelia Earhart:

- **1929 – Woman's speed record 181.18 MPH.**
- **1931 – Autogiro altitude record of 18,451 feet.**

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Lady Pilots

Key Points:

1908, Therese Peltier (France) First Woman to **Pilot an Aircraft**.

1910, Blanche Stuart Scott (USA) First Woman to **Solo an Airplane**.

1910, Raymonde de Laroche (France) **First Woman in the World to Receive a Pilot License** from the Aero-Club of France.

1911, Harriet Quimby (USA) became the **first licensed female aviator in the United States**. She received her license from the Fédération Aéronautique Internationale (FAI), an international organization based in Paris, on July 31, 1911.) In 1912, she became the **first women to fly across the English Channel**.

1921, Bessie Coleman (USA) became the **first African-American woman pilot** and **first African-American women to receive a pilots license** from the FAI.

1927, Phoebe Fairgrave Omlie (USA) received **Transport License** No. 199 from the Aeronautics Branch on June 30, 1927, making her the **first woman to obtain a transport pilot's license from a civilian agency of the U.S. government**.

1932, Amelia Earhart (USA) – **First woman to fly solo across the Atlantic**.

1943, Jacqueline Cochran (USA) – Formed the Woman Airforce Service Pilot (**WASP**). **Held more speed, distance and altitude records in aviation than any other pilot**.

1963, Valentina Tereshkova (USSR) – **First woman to orbit the earth**, 16 June 1963.

1983, Sally Ride (USA) – **First US woman and youngest US astronaut to orbit earth** (crewed the Space Shuttle Challenger in 1983 and 1984).

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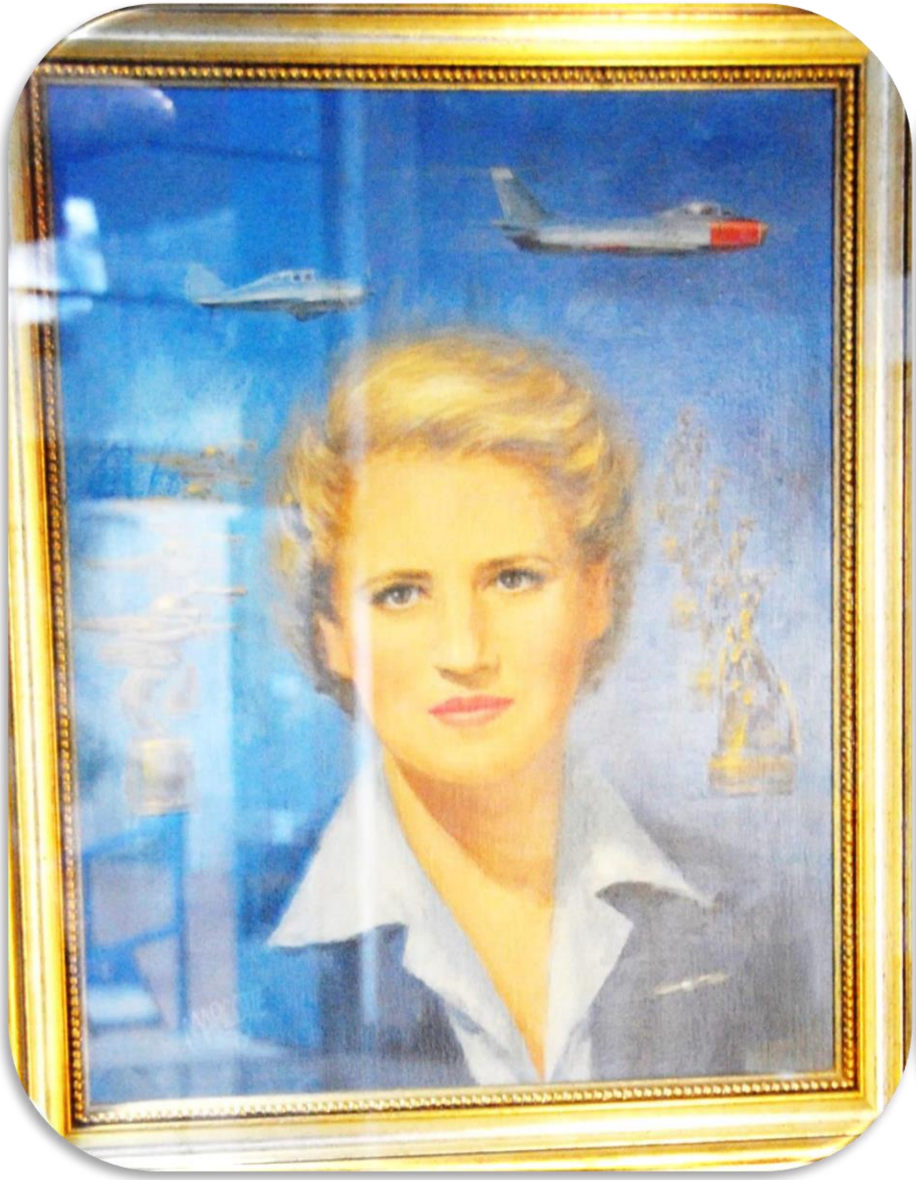

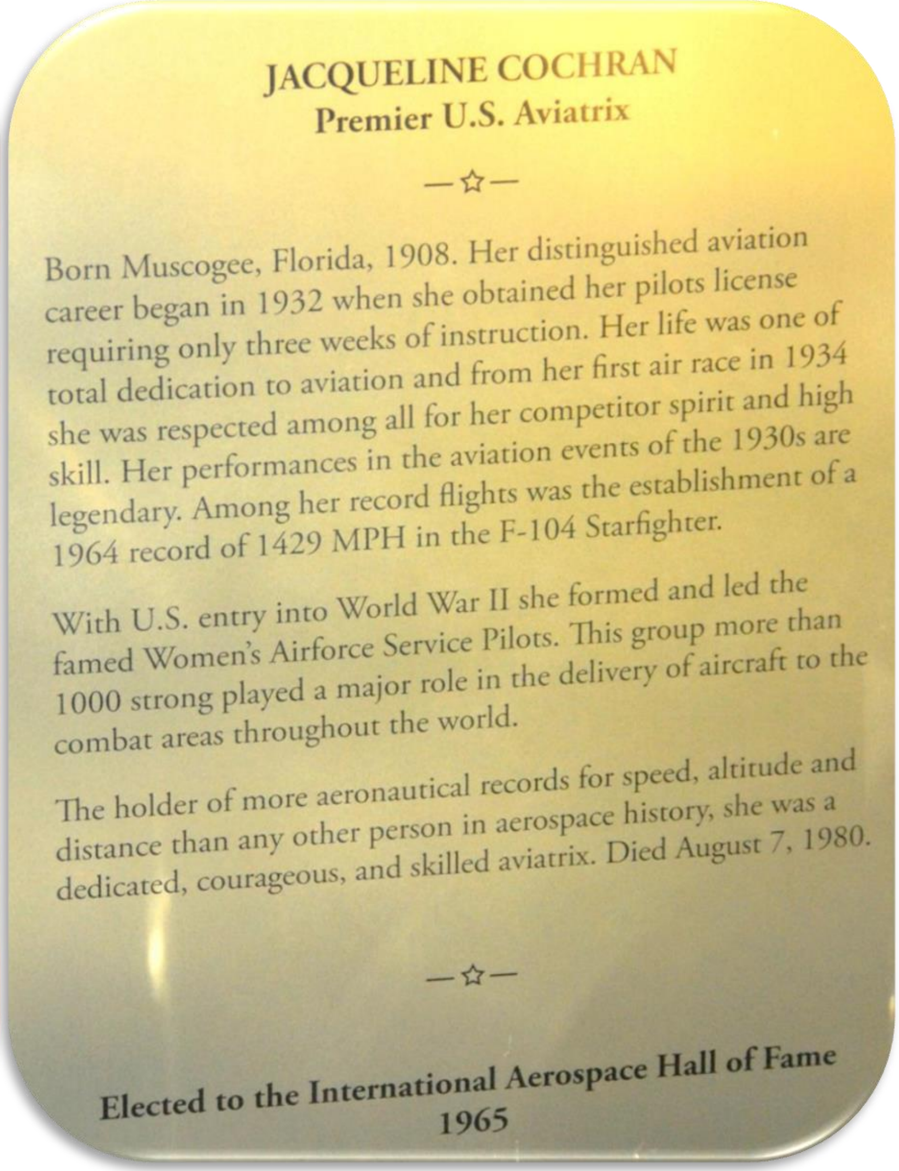

JACQUELINE COCHRAN

Premier U.S. Aviatrix

— ☆ —

Born Muscogee, Florida, 1908. Her distinguished aviation career began in 1932 when she obtained her pilots license requiring only three weeks of instruction. Her life was one of total dedication to aviation and from her first air race in 1934 she was respected among all for her competitor spirit and high skill. Her performances in the aviation events of the 1930s are legendary. Among her record flights was the establishment of a 1964 record of 1429 MPH in the F-104 Starfighter.

With U.S. entry into World War II she formed and led the famed Women's Airforce Service Pilots. This group more than 1000 strong played a major role in the delivery of aircraft to the combat areas throughout the world.

The holder of more aeronautical records for speed, altitude and distance than any other person in aerospace history, she was a dedicated, courageous, and skilled aviatrix. Died August 7, 1980.

— ☆ —

Elected to the International Aerospace Hall of Fame
1965

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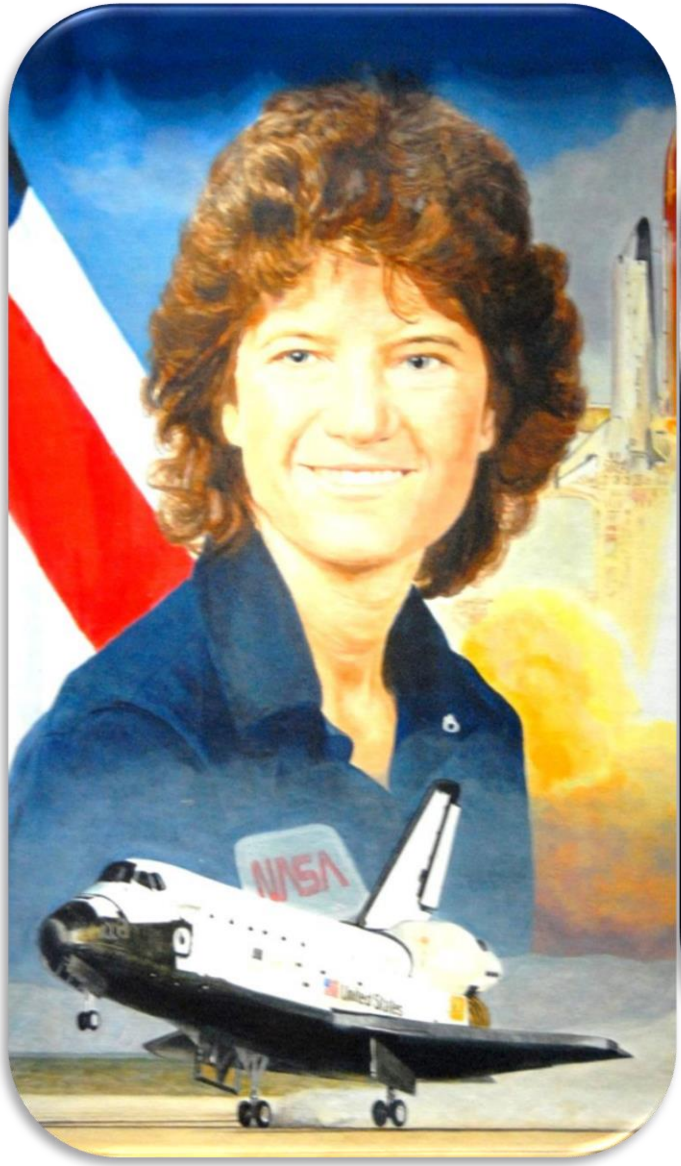

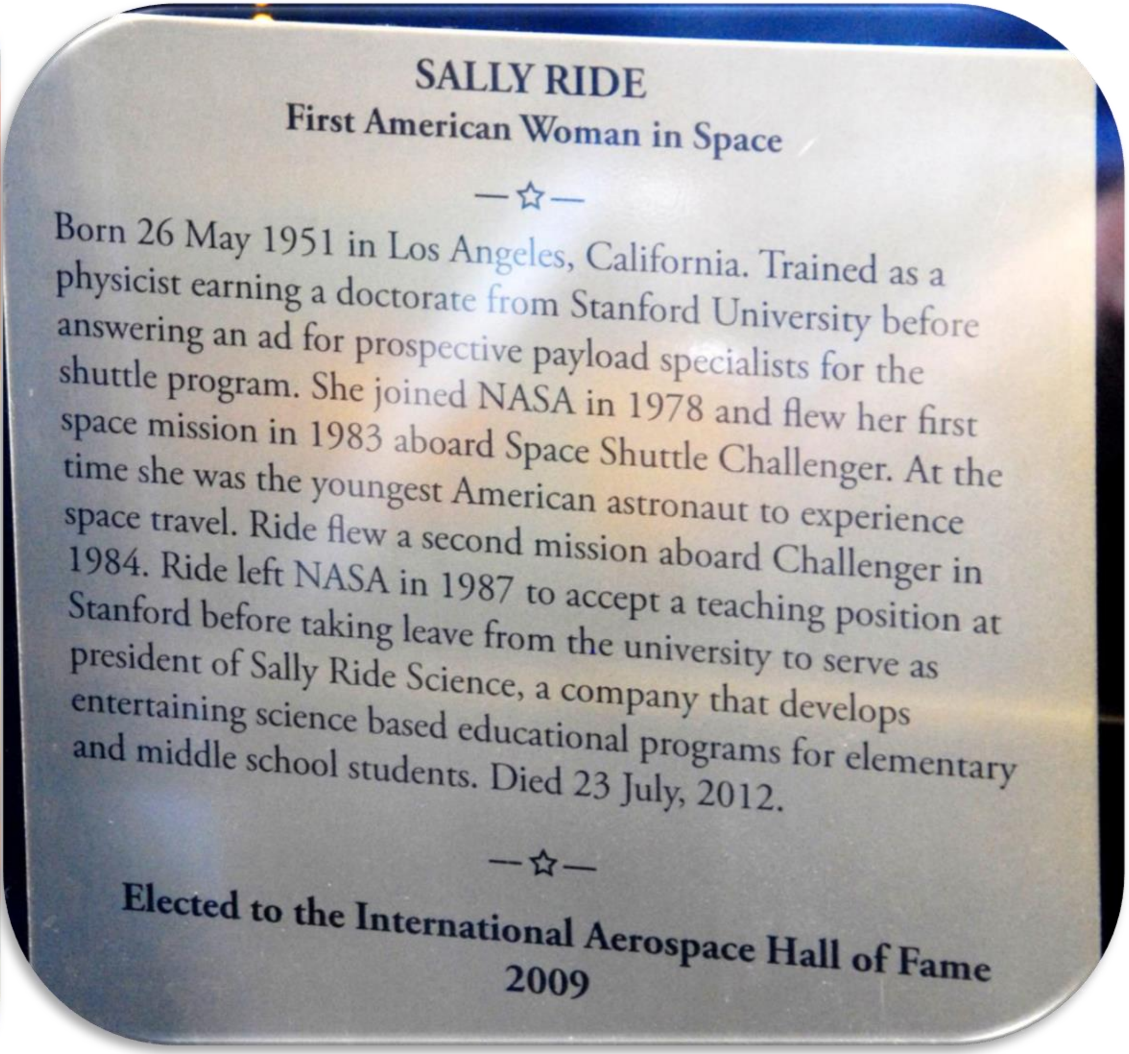

SALLY RIDE

First American Woman in Space

—☆—

Born 26 May 1951 in Los Angeles, California. Trained as a physicist earning a doctorate from Stanford University before answering an ad for prospective payload specialists for the shuttle program. She joined NASA in 1978 and flew her first space mission in 1983 aboard Space Shuttle Challenger. At the time she was the youngest American astronaut to experience space travel. Ride flew a second mission aboard Challenger in 1984. Ride left NASA in 1987 to accept a teaching position at Stanford before taking leave from the university to serve as president of Sally Ride Science, a company that develops entertaining science based educational programs for elementary and middle school students. Died 23 July, 2012.

—☆—

Elected to the International Aerospace Hall of Fame
2009

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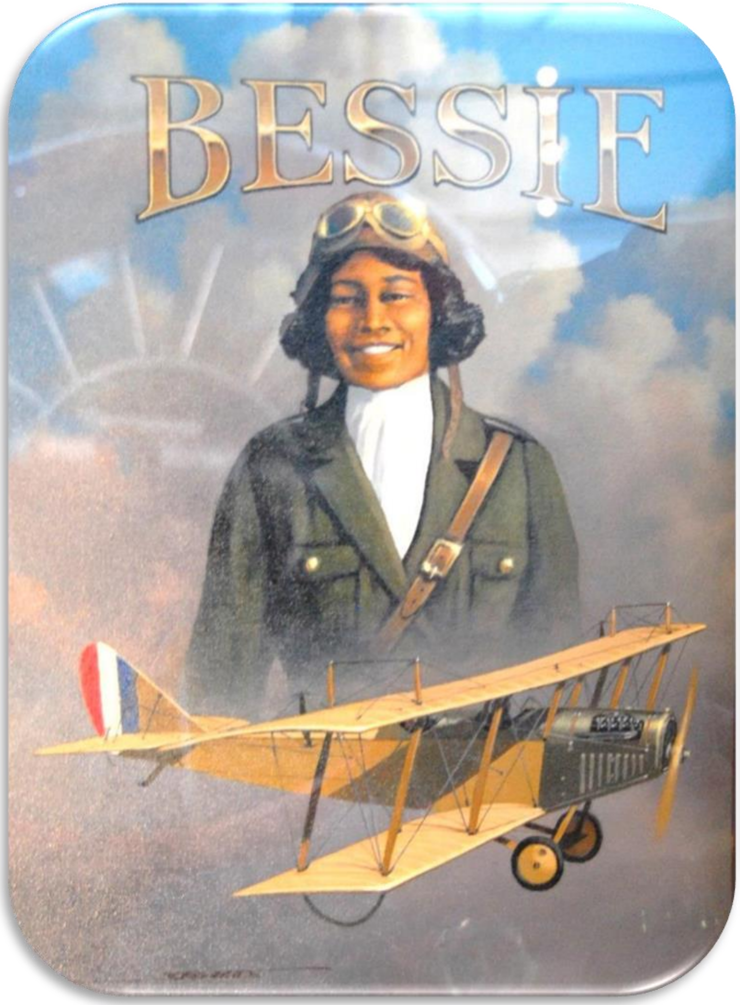

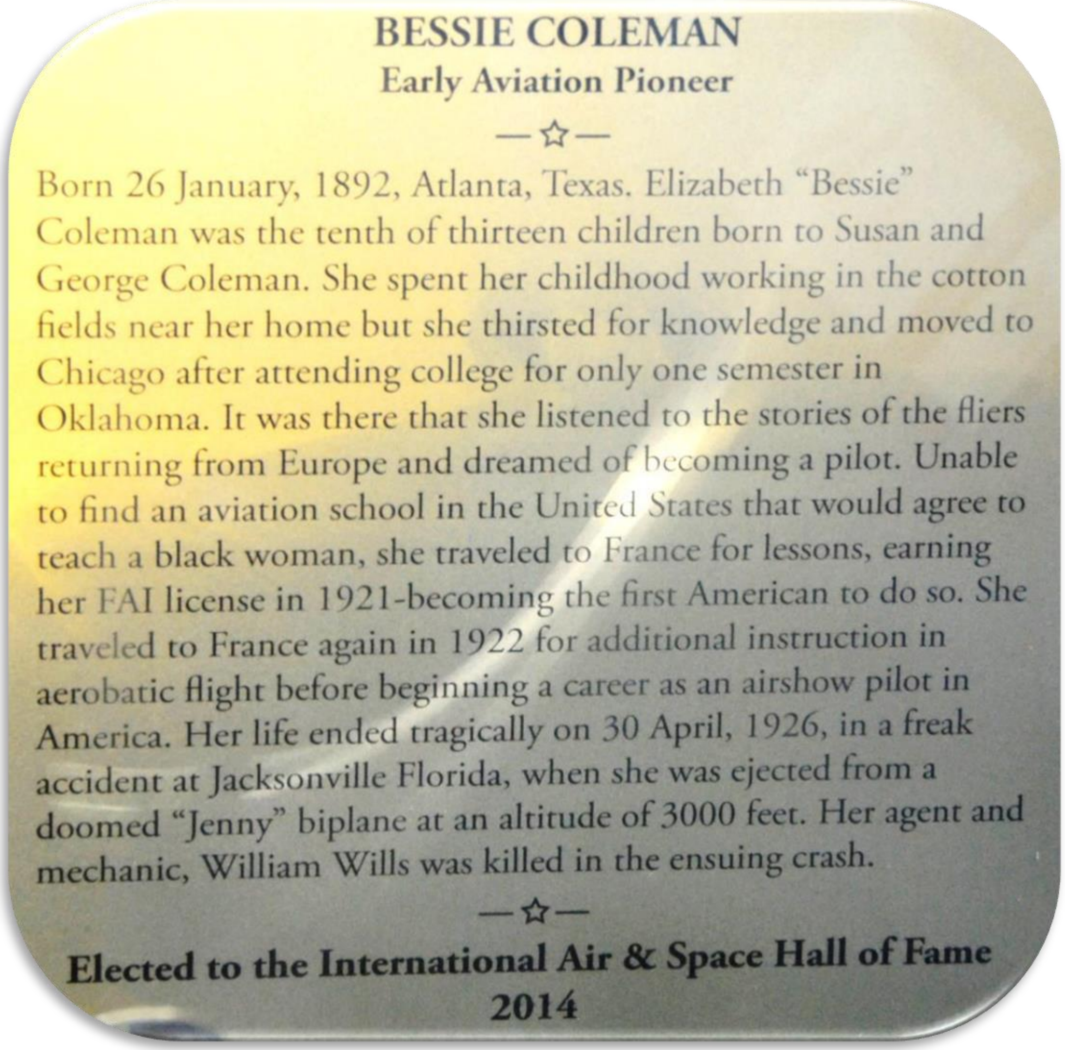

BESSIE COLEMAN

Early Aviation Pioneer

—☆—

Born 26 January, 1892, Atlanta, Texas. Elizabeth "Bessie" Coleman was the tenth of thirteen children born to Susan and George Coleman. She spent her childhood working in the cotton fields near her home but she thirsted for knowledge and moved to Chicago after attending college for only one semester in Oklahoma. It was there that she listened to the stories of the fliers returning from Europe and dreamed of becoming a pilot. Unable to find an aviation school in the United States that would agree to teach a black woman, she traveled to France for lessons, earning her FAI license in 1921-becoming the first American to do so. She traveled to France again in 1922 for additional instruction in aerobatic flight before beginning a career as an airshow pilot in America. Her life ended tragically on 30 April, 1926, in a freak accident at Jacksonville Florida, when she was ejected from a doomed "Jenny" biplane at an altitude of 3000 feet. Her agent and mechanic, William Wills was killed in the ensuing crash.

—☆—

Elected to the International Air & Space Hall of Fame
2014

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Gentlemen Pilots

Key Points:

1783, Jean-François Pilâtre de Rozier and **François Laurent d'Arlandes** (France) **First untethered manned hot air balloon flight in a Montgolfier bro's balloon**.
1883, John J. Montgomery, (USA) **First human-carrying glider flight in America.**
1903, Orville Wright, (USA) Dec 17, 1903, **Worlds first successful powered flight.**
1916/17, Eugene Jacques Bullard, F**irst Haitian-American military pilot,** and probably the first black American to receive a pilot certificate of any type.
1927, Charles A. Lindbergh (USA) **Worlds first person to fly cross the Atlantic**.
1932, James Herman Banning (USA), received a limited commercial license. Banning is the **first known African American to receive a Federal pilot license**.
1932, **C. Alfred "Chief" Anderson** (USA)**,** Is believed to have been the **first African American to receive a Federal Transport Pilot license**.
1947, Charles "Chuck" Yeager, First to exceed the speed of sound in level flight.
1961, Yuri Alekseyevich Gagarin (Russia) **First human in outer space** (Vostok I)**.**
1961, Alan Bartlett Shepard Jr. (USA) **First American to travel into space.**
1962, John Herschel Glenn Jr. (USA) **First American to orbit the Earth.**
1969, Neil Alden Armstrong (USA) **First person to walk on the Moon.**

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Golden Age Gallery

1st flight: 1935

Key Points: **Mural - *Explorer II*** was a manned U.S. high-altitude balloon that launched on November 11, 1935 and reached a **record altitude of 72,395 feet (13.7 miles).** Launched from the Stratobowl in **South Dakota**, the helium balloon carried a two-man crew consisting of U. S. **Army Air Corps Captains** Albert W. **Stevens** and Orvil A. **Anderson** inside a sealed, spherical cabin. The crew landed safely near White Lake, South Dakota and both were acclaimed as national heroes. Scientific instruments carried on the gondola returned useful information about the stratosphere. The mission was funded by the membership of the **National Geographic Society**.

This: In 1936, during the Exposition, the Mural was painted with the original Explorer II gondola on display below this mural.

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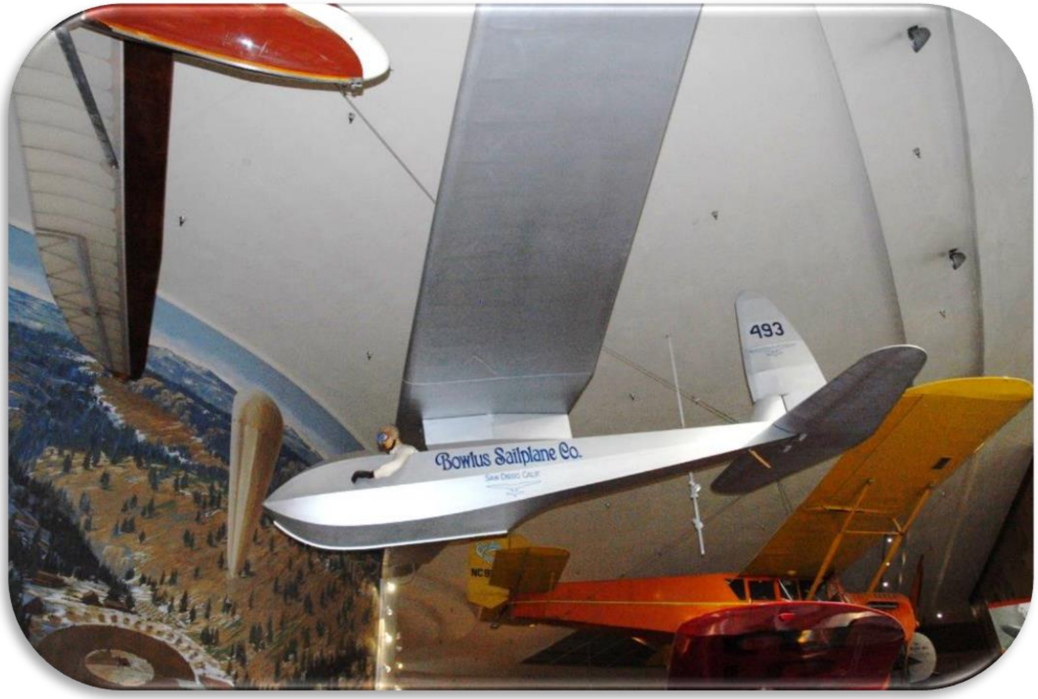

1st flight: 1929
(15 built)

Key Points: **Bowlus SP-1 Albatross** (Reproduction). Original built by **William H. Bowlus**, an engineer for Ryan on the 'Spirit of St Louis' and founder of Bowlus Sailplane Company.
January 1929, completed work on the Albatross, in the same hangar as Spirit built. Used **craft paper with spruce** in the wing ribs, thus nicknamed **"Paper Wing"**. One of the first licensed gliders in the United States.
Jul & Oct, 1929, launched from Mt. Soledad and Pt. Loma to break several gliding records.
Oct, 1929, **1st American glider to fly for over an hour. Trained Charles and Anne Lindbergh (1st female licensed glider pilot).** Note: Another lady pilot, Peaches Wallace, qualified in a glider before Ann Lindberg, however, Anne received her official license first.

This: Built from scratch by museum volunteer technicians in 1988.

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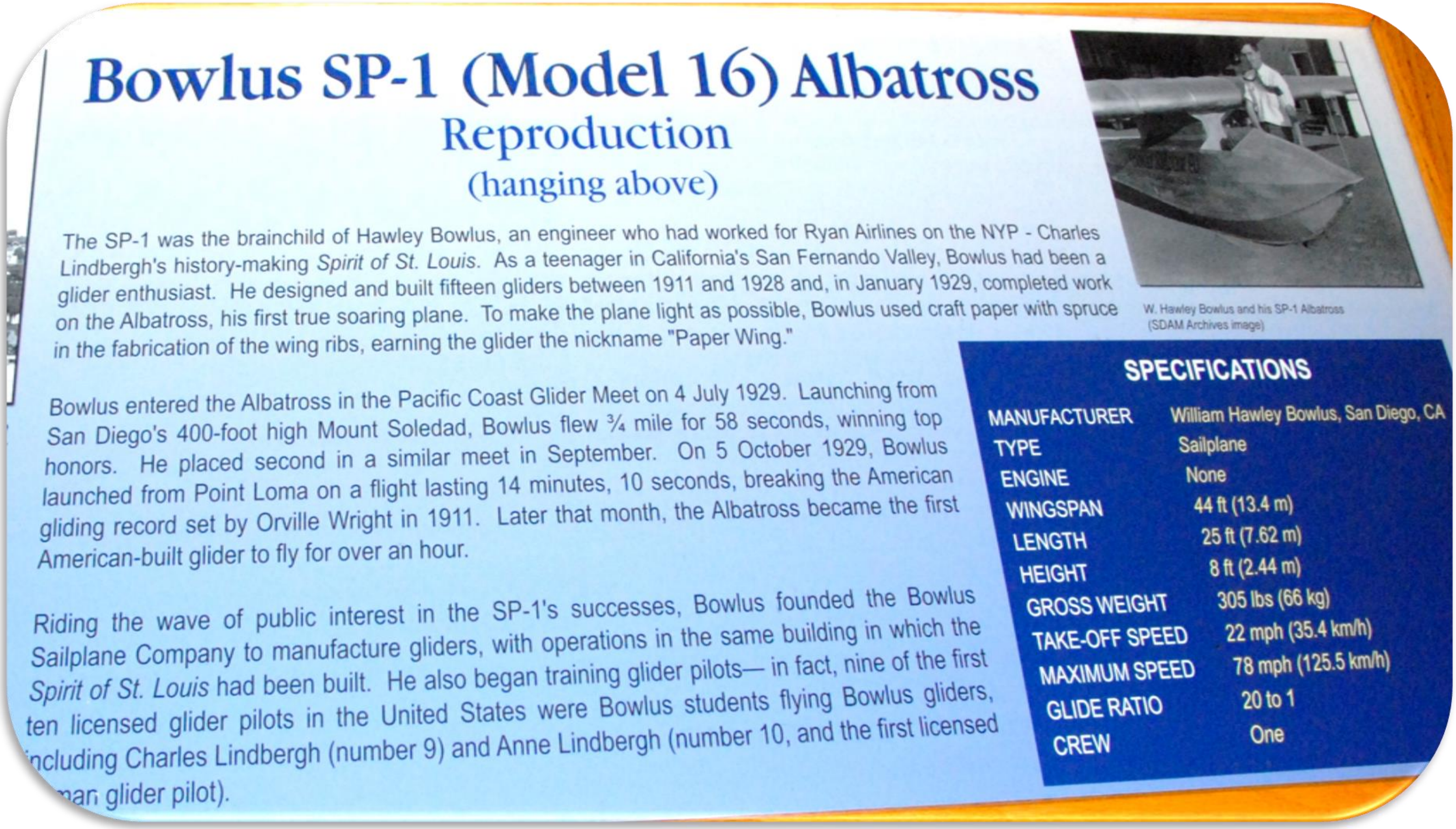

Bowlus SP-1 (Model 16) Albatross

Reproduction

(hanging above)

The SP-1 was the brainchild of Hawley Bowlus, an engineer who had worked for Ryan Airlines on the NYP - Charles Lindbergh's history-making *Spirit of St. Louis*. As a teenager in California's San Fernando Valley, Bowlus had been a glider enthusiast. He designed and built fifteen gliders between 1911 and 1928 and, in January 1929, completed work on the Albatross, his first true soaring plane. To make the plane light as possible, Bowlus used craft paper with spruce in the fabrication of the wing ribs, earning the glider the nickname "Paper Wing."

W. Hawley Bowlus and his SP-1 Albatross
(SDAM Archives image)

Bowlus entered the Albatross in the Pacific Coast Glider Meet on 4 July 1929. Launching from San Diego's 400-foot high Mount Soledad, Bowlus flew ¾ mile for 58 seconds, winning top honors. He placed second in a similar meet in September. On 5 October 1929, Bowlus launched from Point Loma on a flight lasting 14 minutes, 10 seconds, breaking the American gliding record set by Orville Wright in 1911. Later that month, the Albatross became the first American-built glider to fly for over an hour.

Riding the wave of public interest in the SP-1's successes, Bowlus founded the Bowlus Sailplane Company to manufacture gliders, with operations in the same building in which the *Spirit of St. Louis* had been built. He also began training glider pilots— in fact, nine of the first ten licensed glider pilots in the United States were Bowlus students flying Bowlus gliders, ncluding Charles Lindbergh (number 9) and Anne Lindbergh (number 10, and the first licensed man glider pilot).

SPECIFICATIONS

MANUFACTURER	William Hawley Bowlus, San Diego, CA
TYPE	Sailplane
ENGINE	None
WINGSPAN	44 ft (13.4 m)
LENGTH	25 ft (7.62 m)
HEIGHT	8 ft (2.44 m)
GROSS WEIGHT	305 lbs (66 kg)
TAKE-OFF SPEED	22 mph (35.4 km/h)
MAXIMUM SPEED	78 mph (125.5 km/h)
GLIDE RATIO	20 to 1
CREW	One

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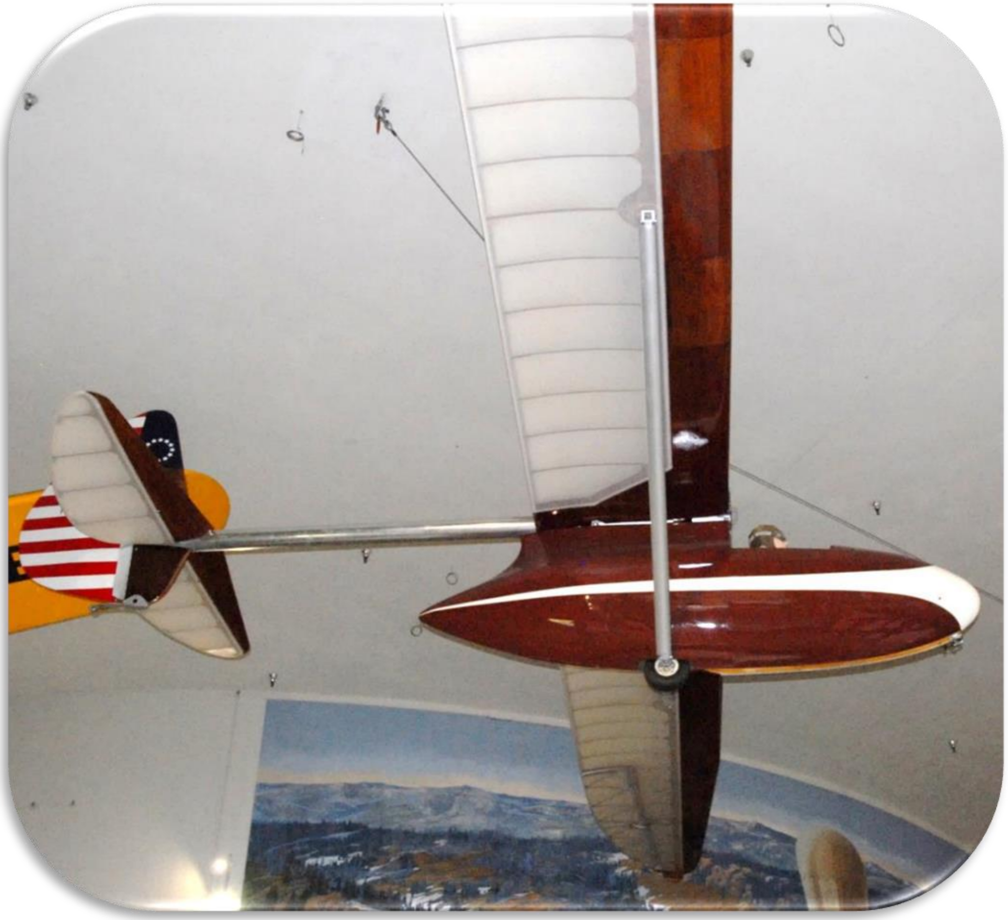

1st flight: 1938
(156 Kits sold)

Key Points: **Bowlus BA-100** (Original) Designed as an inexpensive glider during the Great Depression. $750 for a ready-to-fly sailplane, and $385 as a kit. In 2013, 12 BA-100's still flying.

This: Kit aircraft #11, flew from Torrey Pines Glider Port in 1951. On loan from Wayne Spani.

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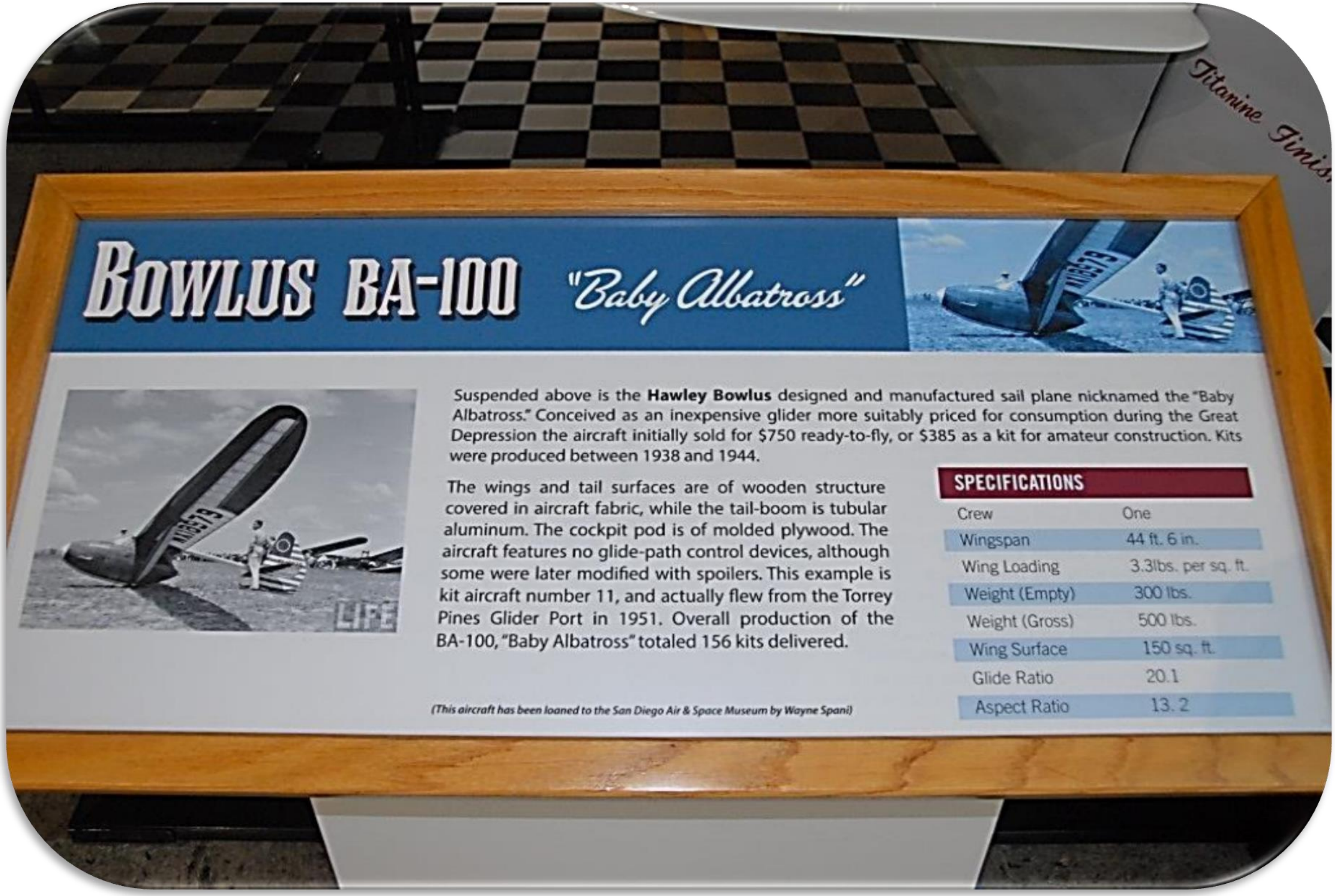

LIFE
Titanine Finis

BOWLUS BA-100 "Baby Albatross"

Suspended above is the **Hawley Bowlus** designed and manufactured sail plane nicknamed the "Baby Albatross." Conceived as an inexpensive glider more suitably priced for consumption during the Great Depression the aircraft initially sold for $750 ready-to-fly, or $385 as a kit for amateur construction. Kits were produced between 1938 and 1944.

The wings and tail surfaces are of wooden structure covered in aircraft fabric, while the tail-boom is tubular aluminum. The cockpit pod is of molded plywood. The aircraft features no glide-path control devices, although some were later modified with spoilers. This example is kit aircraft number 11, and actually flew from the Torrey Pines Glider Port in 1951. Overall production of the BA-100, "Baby Albatross" totaled 156 kits delivered.

(This aircraft has been loaned to the San Diego Air & Space Museum by Wayne Spani)

SPECIFICATIONS

Crew	One
Wingspan	44 ft. 6 in.
Wing Loading	3.3lbs. per sq. ft.
Weight (Empty)	300 lbs.
Weight (Gross)	500 lbs.
Wing Surface	150 sq. ft.
Glide Ratio	20.1
Aspect Ratio	13. 2

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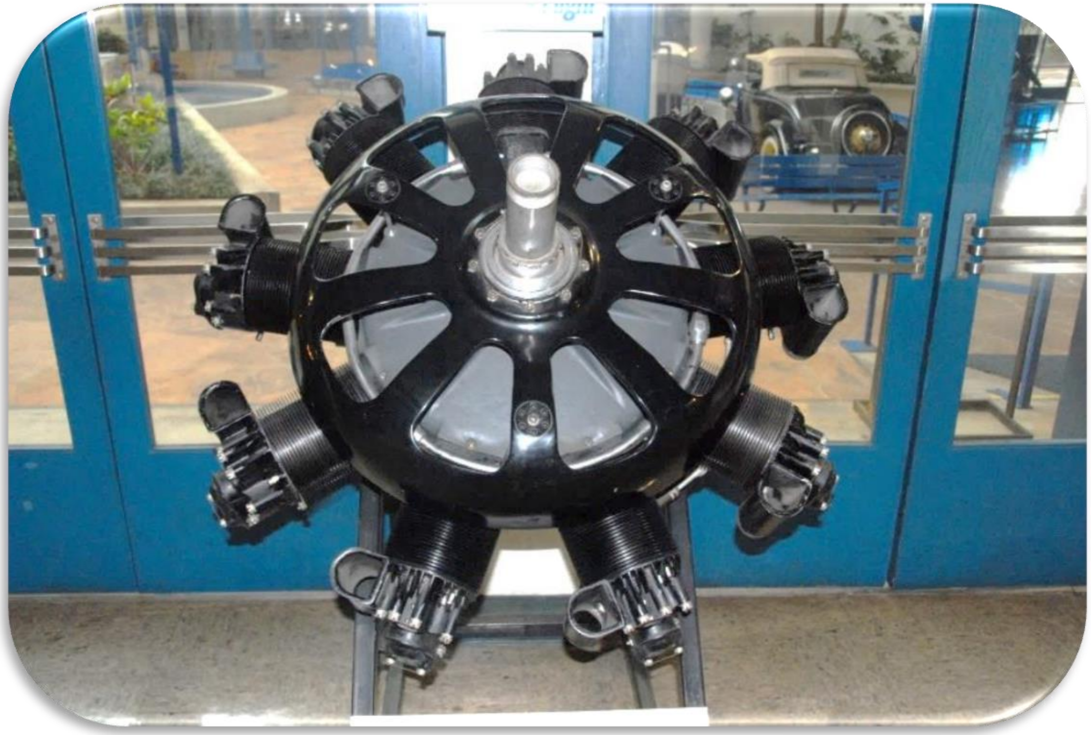
Golden Age Gallery



1st Test Run: 1928
(Approx. 100 built)

Key Points: Type certified 1930, Packard Diesel DR-980 Engine (**Original**). **First aircraft diesel engine, 225 hp**. No carburetor, magnetos, spark plugs, plug wires.

May, 1931, World non-refueling record, Bellanca “Peacemaker”, **84 hours, 32 minutes; not broken until “Rutan Voyager” in 1986.**

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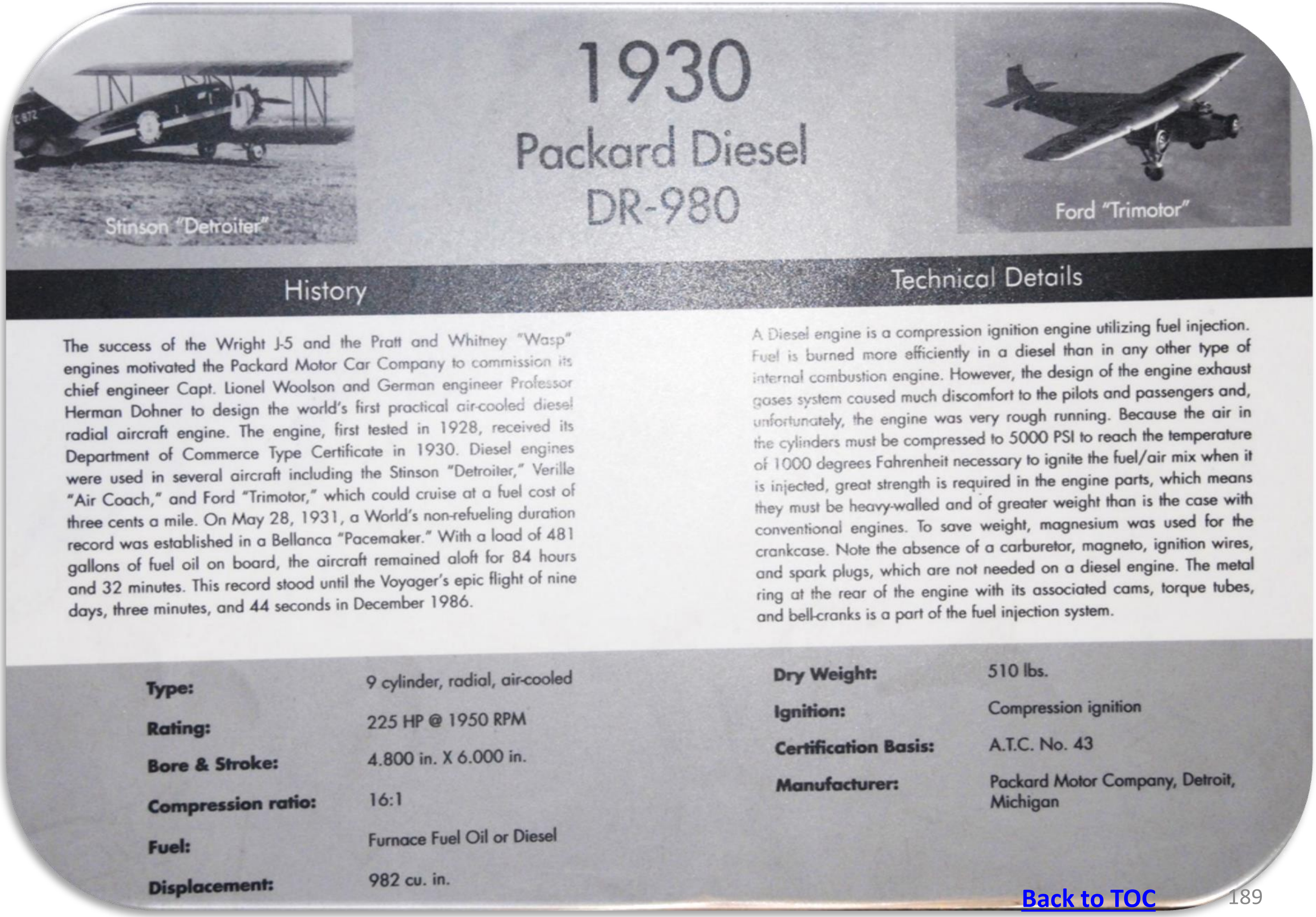

Stinson "Detroiter"

1930

Packard Diesel

DR-980

Ford "Trimotor"

History

The success of the Wright J-5 and the Pratt and Whitney "Wasp" engines motivated the Packard Motor Car Company to commission its chief engineer Capt. Lionel Woolson and German engineer Professor Herman Dohner to design the world's first practical air-cooled diesel radial aircraft engine. The engine, first tested in 1928, received its Department of Commerce Type Certificate in 1930. Diesel engines were used in several aircraft including the Stinson "Detroiter," Verille "Air Coach," and Ford "Trimotor," which could cruise at a fuel cost of three cents a mile. On May 28, 1931, a World's non-refueling duration record was established in a Bellanca "Pacemaker." With a load of 481 gallons of fuel oil on board, the aircraft remained aloft for 84 hours and 32 minutes. This record stood until the Voyager's epic flight of nine days, three minutes, and 44 seconds in December 1986.

Technical Details

A Diesel engine is a compression ignition engine utilizing fuel injection. Fuel is burned more efficiently in a diesel than in any other type of internal combustion engine. However, the design of the engine exhaust gases system caused much discomfort to the pilots and passengers and, unfortunately, the engine was very rough running. Because the air in the cylinders must be compressed to 5000 PSI to reach the temperature of 1000 degrees Fahrenheit necessary to ignite the fuel/air mix when it is injected, great strength is required in the engine parts, which means they must be heavy-walled and of greater weight than is the case with conventional engines. To save weight, magnesium was used for the crankcase. Note the absence of a carburetor, magneto, ignition wires, and spark plugs, which are not needed on a diesel engine. The metal ring at the rear of the engine with its associated cams, torque tubes, and bell-cranks is a part of the fuel injection system.

Type:	9 cylinder, radial, air-cooled
Rating:	225 HP @ 1950 RPM
Bore & Stroke:	4.800 in. X 6.000 in.
Compression ratio:	16:1
Fuel:	Furnace Fuel Oil or Diesel
Displacement:	982 cu. in.

Dry Weight:	510 lbs.
Ignition:	Compression ignition
Certification Basis:	A.T.C. No. 43
Manufacturer:	Packard Motor Company, Detroit, Michigan

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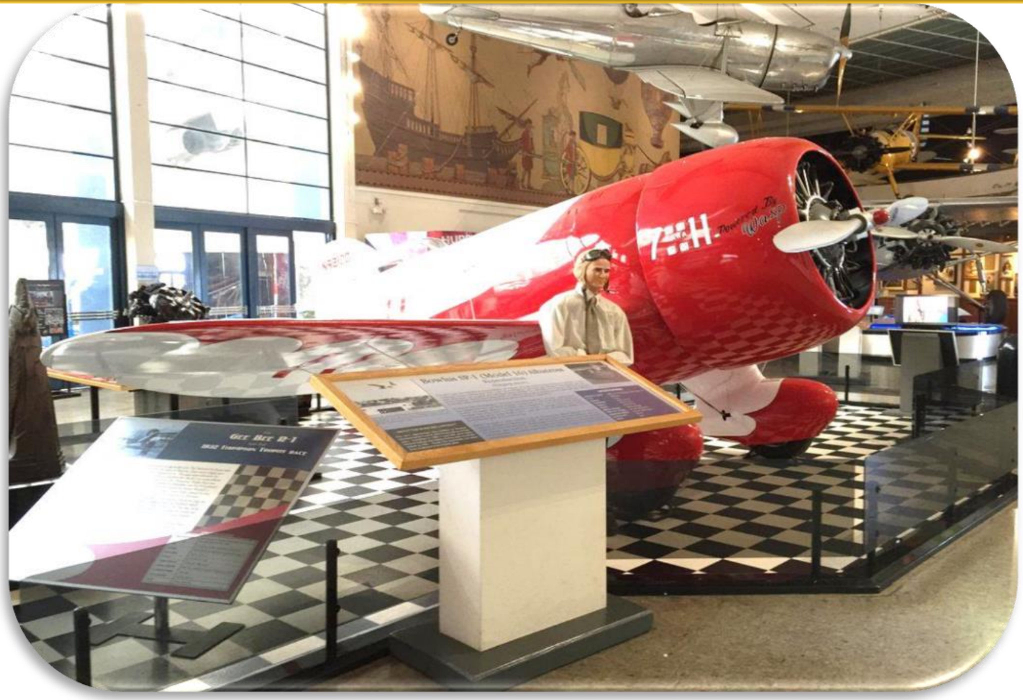

1st flight: 1932
(Few built)

Key Points: **Granville Gee Bee R-1** (Reproduction), designed by five brothers known as "The **Granville Brothers**," hence "GB" or "Gee Bee." GB Firm operated **1929** to **1934**. **National Air Races in 1932, Jimmy Doolittle flew the R-1 to a new world's land-plane speed record of 296 mph**, and **then won the Thompson Trophy Race at 252.7 mph. Many Gee Bee's crashed**, and became known as a treacherous aircraft. **Doolittle figured he had used up all his luck in 1932 and never flew it again.** To save money, the Gee Bee used Ford Model T steering rods (aileron controls), Chevy shift knob (throttle lever), Indian motorcycle throttle handgrip (control stick).

This: Built by Museum volunteers in 2009, using original plans obtained from the New England Air Museum, and is **one of only two on display in the world**. Back to TOC

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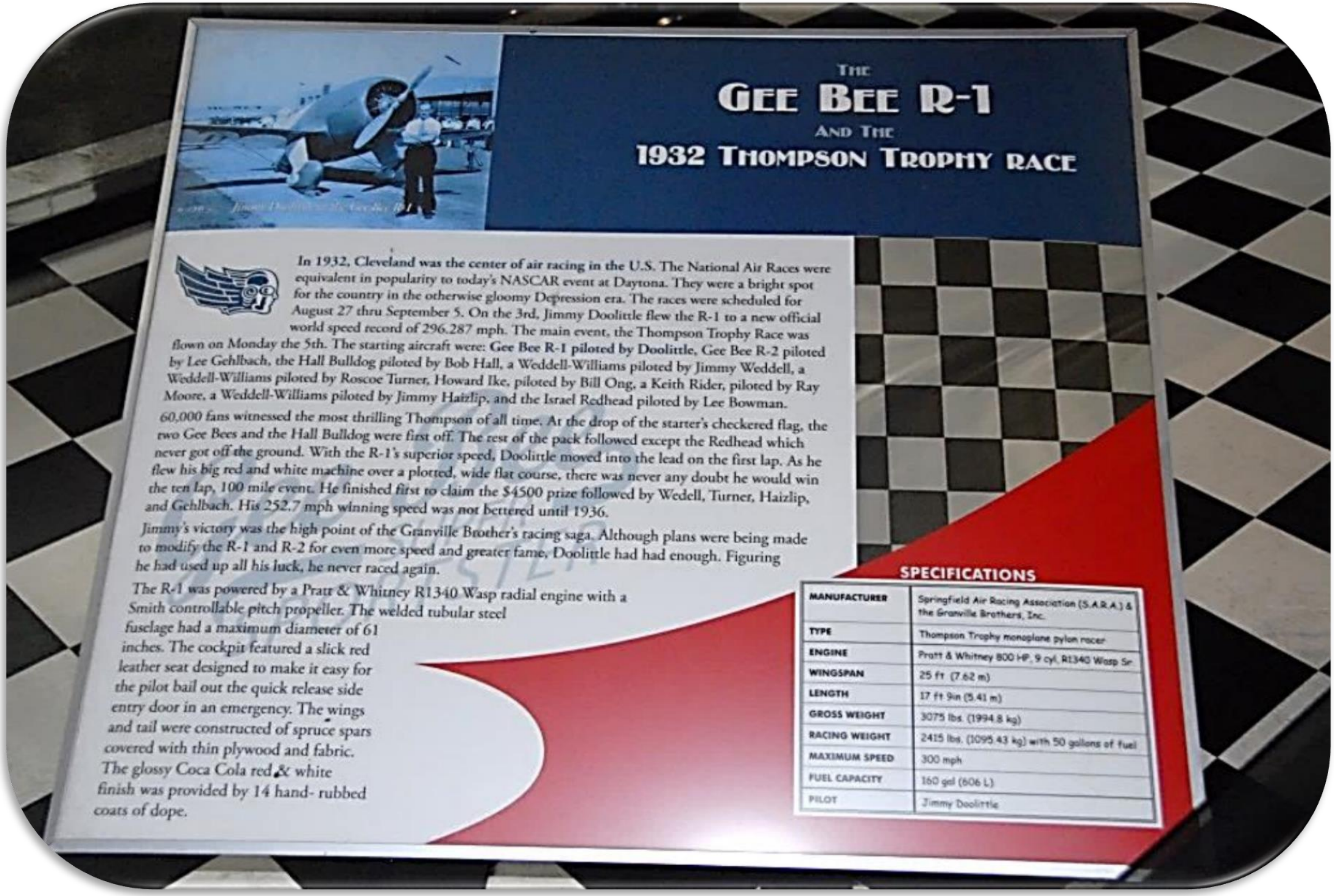

THE
GEE BEE R-1
AND THE
1932 THOMPSON TROPHY RACE

In 1932, Cleveland was the center of air racing in the U.S. The National Air Races were equivalent in popularity to today's NASCAR event at Daytona. They were a bright spot for the country in the otherwise gloomy Depression era. The races were scheduled for August 27 thru September 5. On the 3rd, Jimmy Doolittle flew the R-1 to a new official world speed record of 296.287 mph. The main event, the Thompson Trophy Race was flown on Monday the 5th. The starting aircraft were: Gee Bee R-1 piloted by Doolittle, Gee Bee R-2 piloted by Lee Gehlbach, the Hall Bulldog piloted by Bob Hall, a Weddell-Williams piloted by Jimmy Weddell, a Weddell-Williams piloted by Roscoe Turner, Howard Ike, piloted by Bill Ong, a Keith Rider, piloted by Ray Moore, a Weddell-Williams piloted by Jimmy Haizlip, and the Israel Redhead piloted by Lee Bowman.

60,000 fans witnessed the most thrilling Thompson of all time. At the drop of the starter's checkered flag, the two Gee Bees and the Hall Bulldog were first off. The rest of the pack followed except the Redhead which never got off the ground. With the R-1's superior speed, Doolittle moved into the lead on the first lap. As he flew his big red and white machine over a plotted, wide flat course, there was never any doubt he would win the ten lap, 100 mile event. He finished first to claim the $4500 prize followed by Wedell, Turner, Haizlip, and Gehlbach. His 252.7 mph winning speed was not bettered until 1936.

Jimmy's victory was the high point of the Granville Brother's racing saga. Although plans were being made to modify the R-1 and R-2 for even more speed and greater fame, Doolittle had had enough. Figuring he had used up all his luck, he never raced again.

The R-1 was powered by a Pratt & Whitney R1340 Wasp radial engine with a Smith controllable pitch propeller. The welded tubular steel fuselage had a maximum diameter of 61 inches. The cockpit featured a slick red leather seat designed to make it easy for the pilot bail out the quick release side entry door in an emergency. The wings and tail were constructed of spruce spars covered with thin plywood and fabric. The glossy Coca Cola red & white finish was provided by 14 hand- rubbed coats of dope.

SPECIFICATIONS

MANUFACTURER	Springfield Air Racing Association (S.A.R.A.) & the Granville Brothers, Inc.
TYPE	Thompson Trophy monoplane pylon racer
ENGINE	Pratt & Whitney 800 HP, 9 cyl, R1340 Wasp Sr
WINGSPAN	25 ft (7.62 m)
LENGTH	17 ft 9in (5.41 m)
GROSS WEIGHT	3075 lbs. (1994.8 kg)
RACING WEIGHT	2415 lbs. (1095.43 kg) with 50 gallons of fuel
MAXIMUM SPEED	300 mph
FUEL CAPACITY	160 gal (606 L)
PILOT	Jimmy Doolittle

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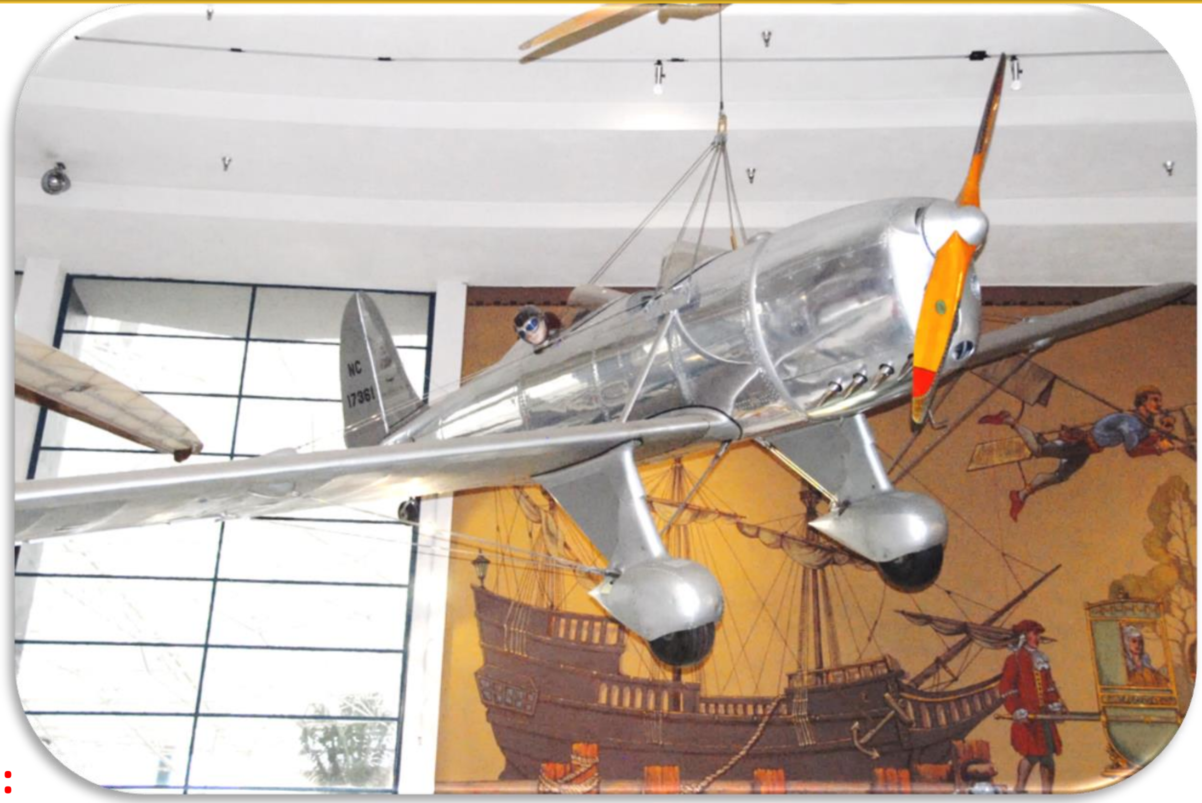

1st flight: 1934
(1568 built)

Key Points:

Ryan STA (**Original**). The Ryan ST family, 1 of **most popular & and successful civilian sport airplanes in history**. **Fully aerobatic**, ST (sport trainer) 95-hp Menasco B4 inverted inline engine. STA fitted with 125-hp or 134-hp. **Hollywood pilot Tex Rankin, 1937, Intl Aerobatic Champion. Transcontinental & Canada-to-Mexico records**. Guatemalan Air Force armed them as fighters. Service in South Africa, Mexico, Honduras, Bolivia and China.

This: Donated by T. Claude Ryan, founder of Ryan Aircraft. Purchased in April 1979, specifically for the Museum to help rebuild, after the fire in 1978.

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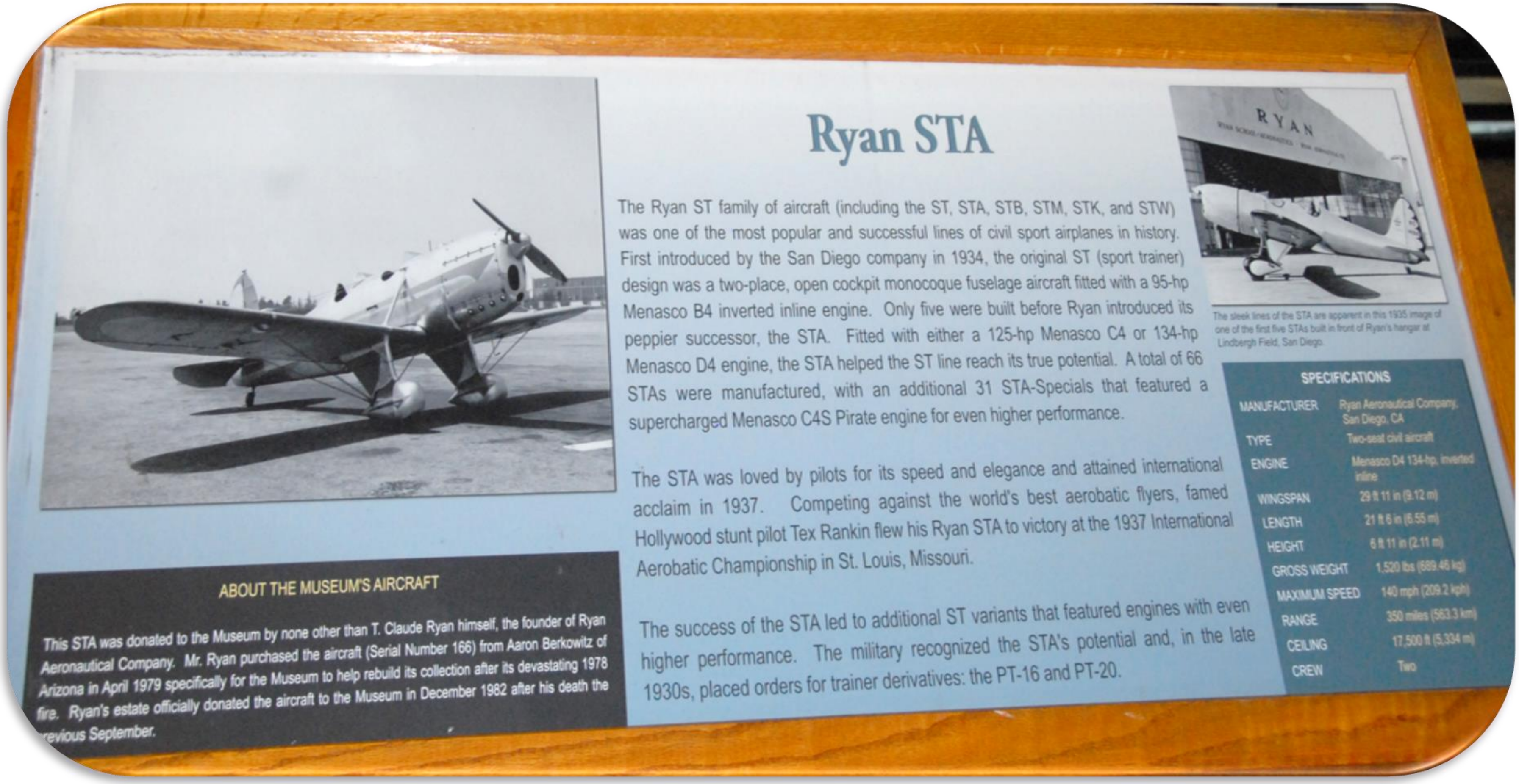


Ryan STA

The Ryan ST family of aircraft (including the ST, STA, STB, STM, STK, and STW) was one of the most popular and successful lines of civil sport airplanes in history. First introduced by the San Diego company in 1934, the original ST (sport trainer) design was a two-place, open cockpit monocoque fuselage aircraft fitted with a 95-hp Menasco B4 inverted inline engine. Only five were built before Ryan introduced its peppier successor, the STA. Fitted with either a 125-hp Menasco C4 or 134-hp Menasco D4 engine, the STA helped the ST line reach its true potential. A total of 66 STAs were manufactured, with an additional 31 STA-Specials that featured a supercharged Menasco C4S Pirate engine for even higher performance.

The STA was loved by pilots for its speed and elegance and attained international acclaim in 1937. Competing against the world's best aerobatic flyers, famed Hollywood stunt pilot Tex Rankin flew his Ryan STA to victory at the 1937 International Aerobatic Championship in St. Louis, Missouri.

The success of the STA led to additional ST variants that featured engines with even higher performance. The military recognized the STA's potential and, in the late 1930s, placed orders for trainer derivatives: the PT-16 and PT-20.

The sleek lines of the STA are apparent in this 1935 image of one of the first five STAs built in front of Ryan's hangar at Lindbergh Field, San Diego.

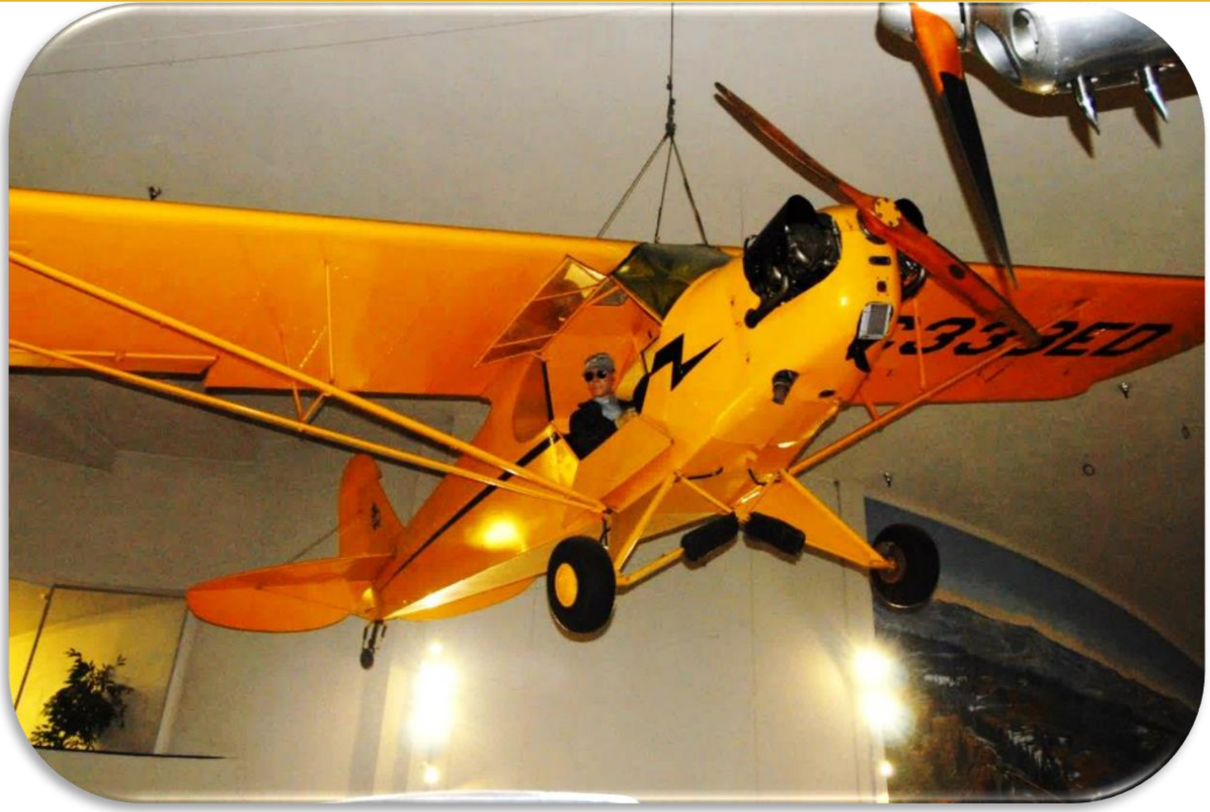
SPECIFICATIONS

MANUFACTURER	Ryan Aeronautical Company, San Diego, CA
TYPE	Two-seat civil aircraft
ENGINE	Menasco D4 134-hp, inverted inline
WINGSPAN	29 ft 11 in (9.12 m)
LENGTH	21 ft 6 in (6.55 m)
HEIGHT	6 ft 11 in (2.11 m)
GROSS WEIGHT	1,520 lbs (689.46 kg)
MAXIMUM SPEED	140 mph (209.2 kph)
RANGE	350 miles (563.3 km)
CEILING	17,500 ft (5,334 m)
CREW	Two

ABOUT THE MUSEUM'S AIRCRAFT

This STA was donated to the Museum by none other than T. Claude Ryan himself, the founder of Ryan Aeronautical Company. Mr. Ryan purchased the aircraft (Serial Number 166) from Aaron Berkowitz of Arizona in April 1979 specifically for the Museum to help rebuild its collection after its devastating 1978 fire. Ryan's estate officially donated the aircraft to the Museum in December 1982 after his death the revious September.

Golden Age Gallery



1st flight: 1937
(14,125 built)

Key Points: **Piper J-3 Cub** (**Original**). The "Model T" of aviation. Built **1938 thru 1947**, characteristic black lightning bolt. **L-4 Grasshopper** was military variant, with radio, extended side windows, 65 hp Continental engine. Used **for reconnaissance, target spotting, liaison, personnel transport, photography, ambulance service**. **One of most popular aircraft in aviation history.**

This: Cub is a J-3C-65 model manufactured in **1939**. Donated, (**airworthy**, 3,008 hours) in 1978 by Ed Norris, Rancho Santa Fe, California.

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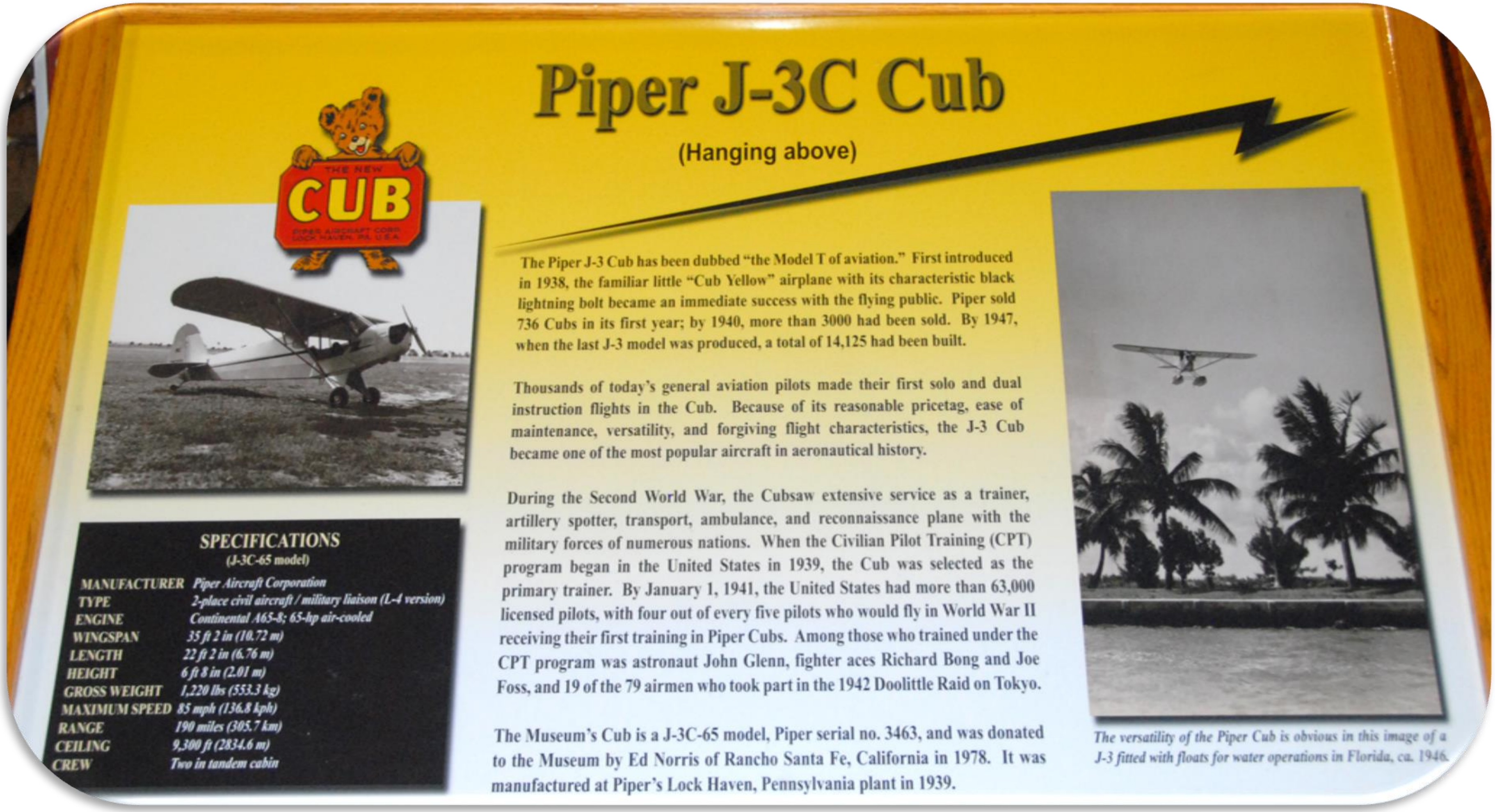


THE NEW
CUB
PIPER AIRCRAFT CORP.
LOCK HAVEN, PA. U.S.A.

Piper J-3C Cub

(Hanging above)

The Piper J-3 Cub has been dubbed "the Model T of aviation." First introduced in 1938, the familiar little "Cub Yellow" airplane with its characteristic black lightning bolt became an immediate success with the flying public. Piper sold 736 Cubs in its first year; by 1940, more than 3000 had been sold. By 1947, when the last J-3 model was produced, a total of 14,125 had been built.

Thousands of today's general aviation pilots made their first solo and dual instruction flights in the Cub. Because of its reasonable pricetag, ease of maintenance, versatility, and forgiving flight characteristics, the J-3 Cub became one of the most popular aircraft in aeronautical history.

During the Second World War, the Cubsaw extensive service as a trainer, artillery spotter, transport, ambulance, and reconnaissance plane with the military forces of numerous nations. When the Civilian Pilot Training (CPT) program began in the United States in 1939, the Cub was selected as the primary trainer. By January 1, 1941, the United States had more than 63,000 licensed pilots, with four out of every five pilots who would fly in World War II receiving their first training in Piper Cubs. Among those who trained under the CPT program was astronaut John Glenn, fighter aces Richard Bong and Joe Foss, and 19 of the 79 airmen who took part in the 1942 Doolittle Raid on Tokyo.

The Museum's Cub is a J-3C-65 model, Piper serial no. 3463, and was donated to the Museum by Ed Norris of Rancho Santa Fe, California in 1978. It was manufactured at Piper's Lock Haven, Pennsylvania plant in 1939.

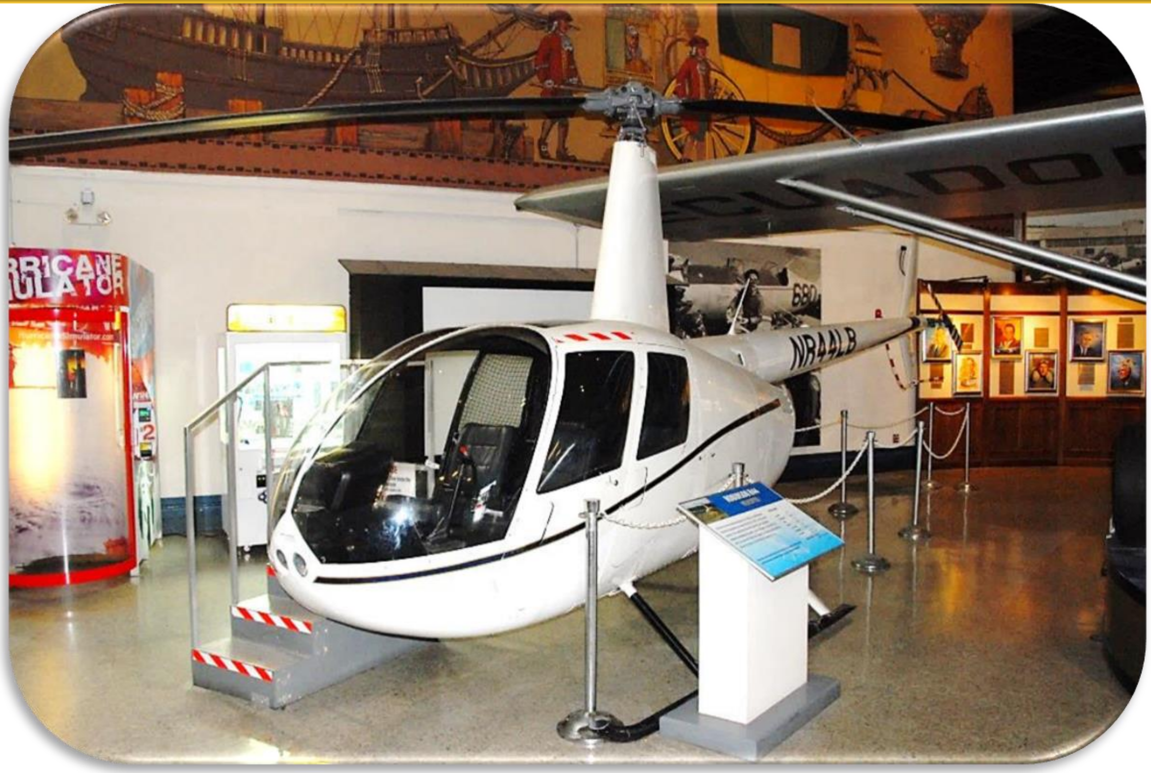
SPECIFICATIONS

(J-3C-65 model)

MANUFACTURER	*Piper Aircraft Corporation*
TYPE	*2-place civil aircraft / military liaison (L-4 version)*
ENGINE	*Continental A65-8; 65-hp air-cooled*
WINGSPAN	*35 ft 2 in (10.72 m)*
LENGTH	*22 ft 2 in (6.76 m)*
HEIGHT	*6 ft 8 in (2.01 m)*
GROSS WEIGHT	*1,220 lbs (553.3 kg)*
MAXIMUM SPEED	*85 mph (136.8 kph)*
RANGE	*190 miles (305.7 km)*
CEILING	*9,300 ft (2834.6 m)*
CREW	*Two in tandem cabin*

The versatility of the Piper Cub is obvious in this image of a J-3 fitted with floats for water operations in Florida, ca. 1946.

Golden Age Gallery



1st flight: 1990
(Over 12,000
Robinson R22,
R44 & R66 built as
of 2017)

Key Points: **Robinson R44 Helicopter** (**Original**). Semi-rigid two-bladed rotor. Lycoming 6 cylinder, flat engine with fuel injection, 245 bhp, cruise speed 130, top speed 150 mph, range 350 miles. Pilot and three passengers. **First flew on March 31, 1990, production in January 1993**. **1997**, piloted by **Jennifer Murray, first helicopter circumnavigation of the world by a woman, covering a distance of 36,000 miles in 97 days.. R66 is turbine powered. Best selling General Aviation helicopter in US.**

This: Minor mishap 2008, at Montgomery Field, the owner donated the aircraft to the Museum. Restored by Gillespie Volunteers.

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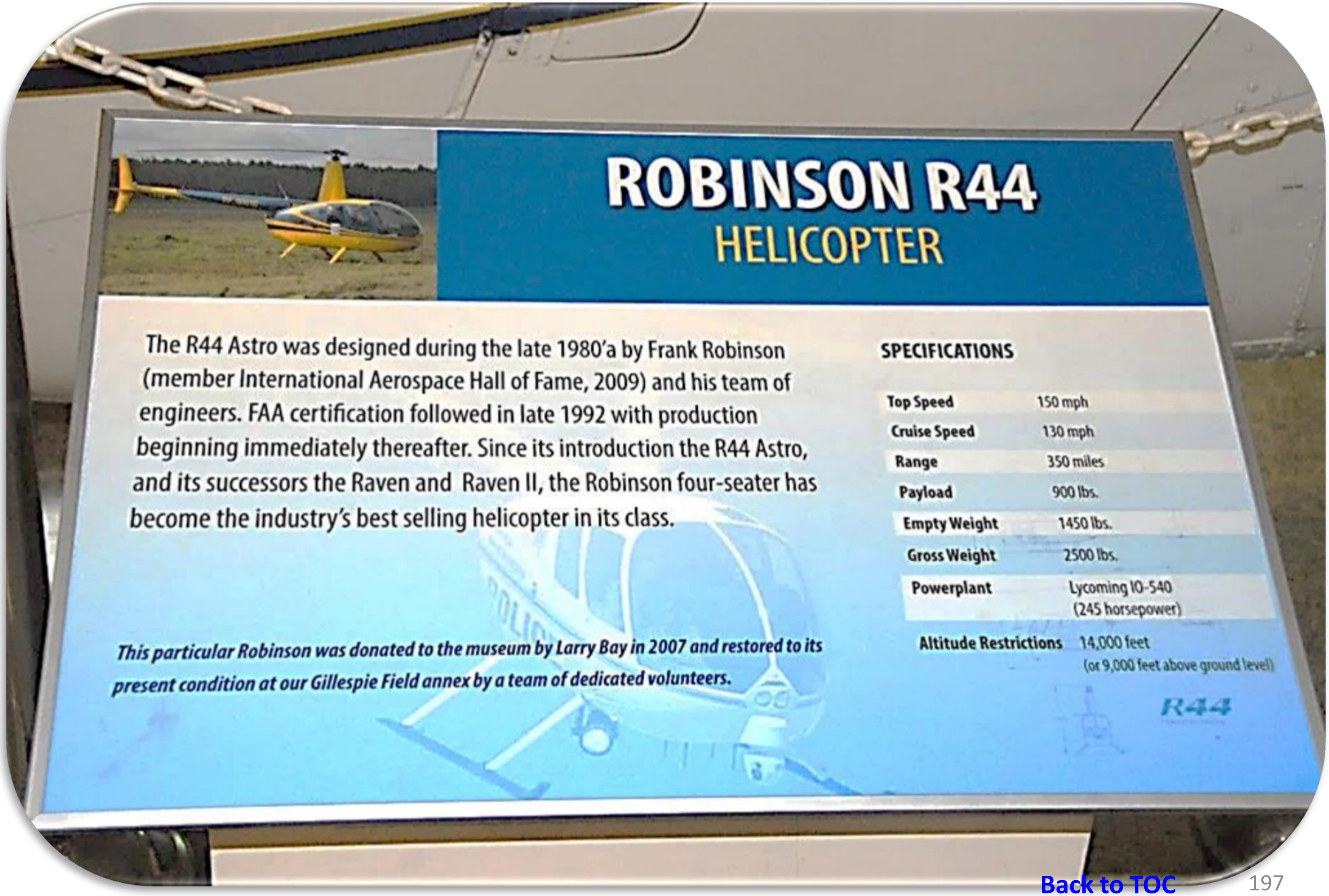

ROBINSON R44
HELICOPTER

The R44 Astro was designed during the late 1980'a by Frank Robinson (member International Aerospace Hall of Fame, 2009) and his team of engineers. FAA certification followed in late 1992 with production beginning immediately thereafter. Since its introduction the R44 Astro, and its successors the Raven and Raven II, the Robinson four-seater has become the industry's best selling helicopter in its class.

This particular Robinson was donated to the museum by Larry Bay in 2007 and restored to its present condition at our Gillespie Field annex by a team of dedicated volunteers.

SPECIFICATIONS

Top Speed	150 mph
Cruise Speed	130 mph
Range	350 miles
Payload	900 lbs.
Empty Weight	1450 lbs.
Gross Weight	2500 lbs.
Powerplant	Lycoming IO-540 (245 horsepower)
Altitude Restrictions	14,000 feet (or 9,000 feet above ground level)

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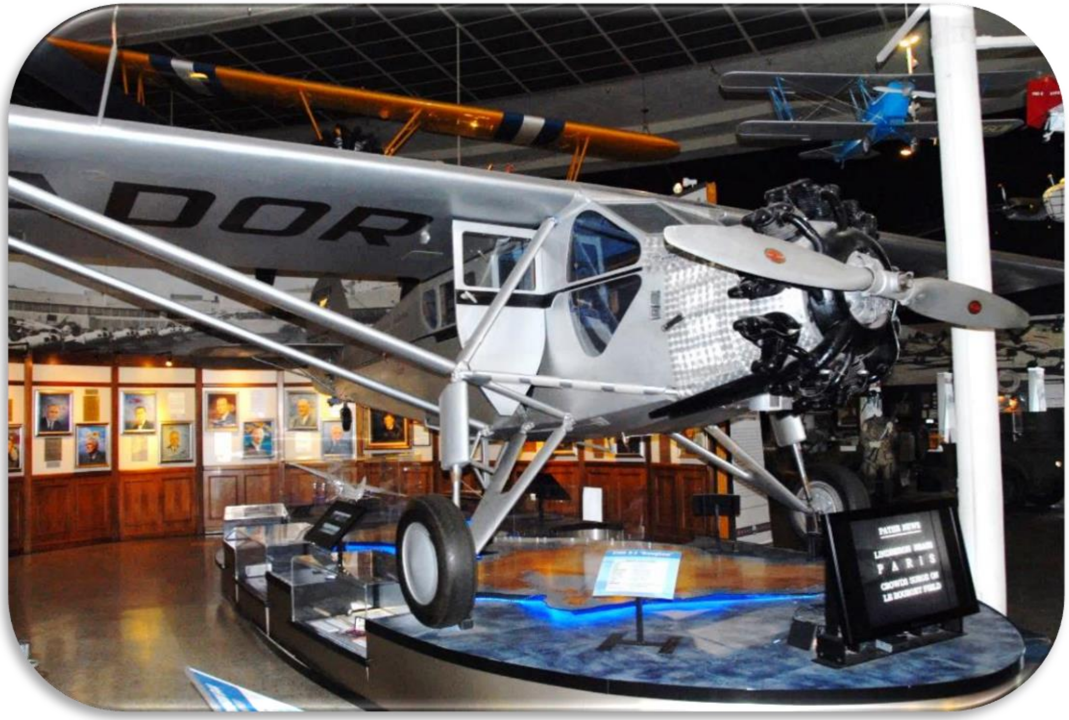

1st flight: 1927
(212 built)

Key Points: **Ryan B-5 Brougham** (**Original**). After Ryan built the M-1, the company built the Ryan Brougham, **commercial version of the Spirit of St. Louis**. 300 hp Wright J6 engine, six people and 100 gallons, take-off in less than 300 feet. Max speed **138mph**, range **750 miles**. **Mar, 1931**, **San Diego to Ecuador flight**, **Theodore Gildred**, Dean Farran, **18 days, 13 stops**, Mexico, Guatemala, Nicaragua, Costa Rica, Panama and Ecuador. **Mar, 1981**, **Theodore Gildred Jr., flew Lindbergh Field to Quito, Ecuador**.

This: Built in **1931**. painted like its sister ship, the ***Ecuador***, which was flown from San Diego to Quito, Ecuador in 1931. 1980, completely restored by volunteers. Aircraft was donated to the Museum by the South Shore Bank.

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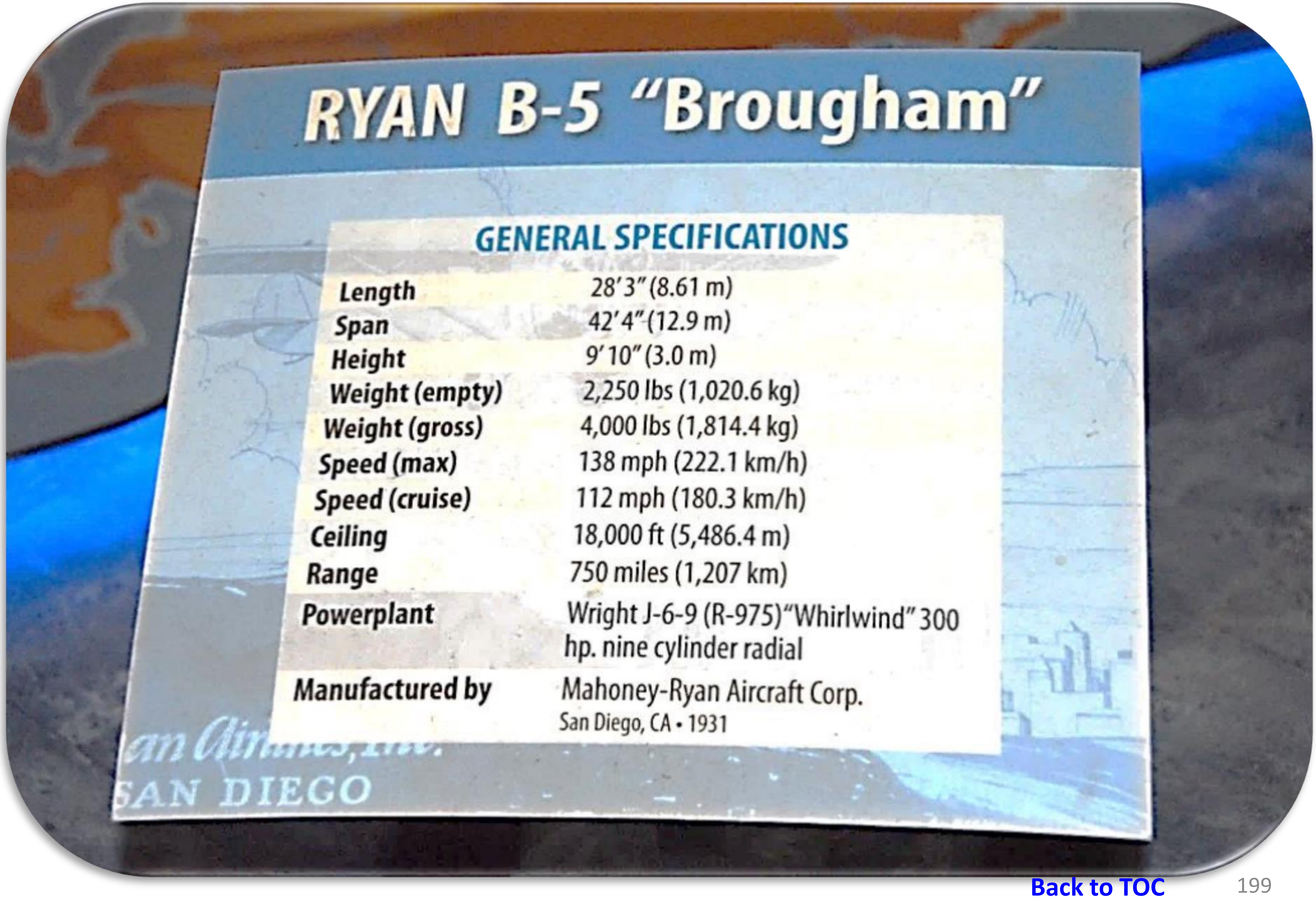
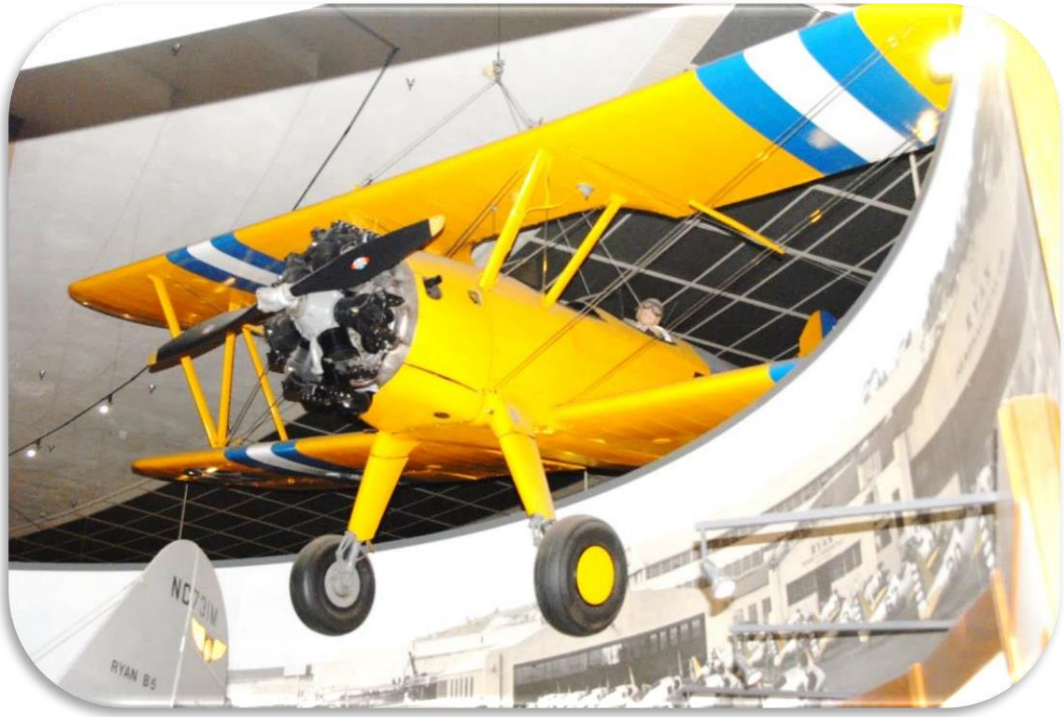


RYAN B-5 “Brougham”

GENERAL SPECIFICATIONS

Length	28′3″ (8.61 m)
Span	42′4″ (12.9 m)
Height	9′10″ (3.0 m)
Weight (empty)	2,250 lbs (1,020.6 kg)
Weight (gross)	4,000 lbs (1,814.4 kg)
Speed (max)	138 mph (222.1 km/h)
Speed (cruise)	112 mph (180.3 km/h)
Ceiling	18,000 ft (5,486.4 m)
Range	750 miles (1,207 km)
Powerplant	Wright J-6-9 (R-975) “Whirlwind” 300 hp. nine cylinder radial
Manufactured by	Mahoney-Ryan Aircraft Corp. San Diego, CA • 1931

Golden Age Gallery



1st flight: 1934
(10,600+ built)

Key Points: **Stearman N2S-3 Kaydet** (Original). **Built in greater quantities than any other known biplane**. Tested by both the Army and the Navy in 1934, by **February 1945, more than 10,600 had been built**. Officially named the Boeing Model 75, the plane was (and still is) persistently known as the "**Stearman**", in recognition of its original manufacturer. It was called the "PT" by the Army, "N2S" by the Navy. **Virtually every American pilot during world war II, went through flight training in a Stearman**.

This: Manufactured by Stearman in **1934**. Painted in standard Navy yellow and blue colors. Flown by then 2LT Greg "Pappy" Boyington, 1936, Pensacola NAS. It was purchased in flyable condition by the Museum from William Rennie in 1979.

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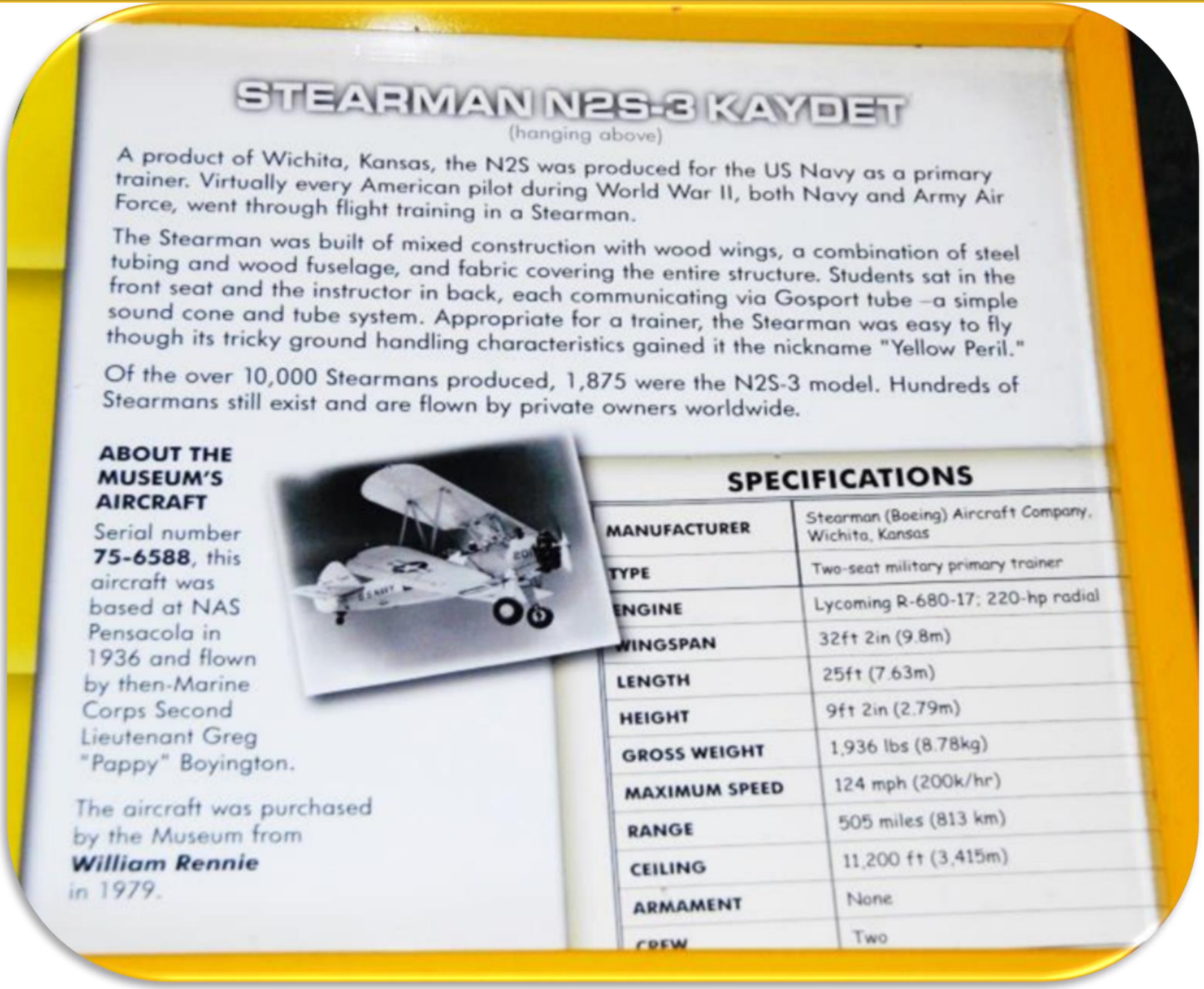

STEARMAN N2S-3 KAYDET

(hanging above)

A product of Wichita, Kansas, the N2S was produced for the US Navy as a primary trainer. Virtually every American pilot during World War II, both Navy and Army Air Force, went through flight training in a Stearman.

The Stearman was built of mixed construction with wood wings, a combination of steel tubing and wood fuselage, and fabric covering the entire structure. Students sat in the front seat and the instructor in back, each communicating via Gosport tube –a simple sound cone and tube system. Appropriate for a trainer, the Stearman was easy to fly though its tricky ground handling characteristics gained it the nickname "Yellow Peril."

Of the over 10,000 Stearmans produced, 1,875 were the N2S-3 model. Hundreds of Stearmans still exist and are flown by private owners worldwide.

ABOUT THE MUSEUM'S AIRCRAFT

Serial number **75-6588**, this aircraft was based at NAS Pensacola in 1936 and flown by then-Marine Corps Second Lieutenant Greg "Pappy" Boyington.

The aircraft was purchased by the Museum from ***William Rennie*** in 1979.

SPECIFICATIONS

MANUFACTURER	Stearman (Boeing) Aircraft Company, Wichita, Kansas
TYPE	Two-seat military primary trainer
ENGINE	Lycoming R-680-17; 220-hp radial
WINGSPAN	32ft 2in (9.8m)
LENGTH	25ft (7.63m)
HEIGHT	9ft 2in (2.79m)
GROSS WEIGHT	1,936 lbs (8.78kg)
MAXIMUM SPEED	124 mph (200k/hr)
RANGE	505 miles (813 km)
CEILING	11,200 ft (3,415m)
ARMAMENT	None
CREW	Two

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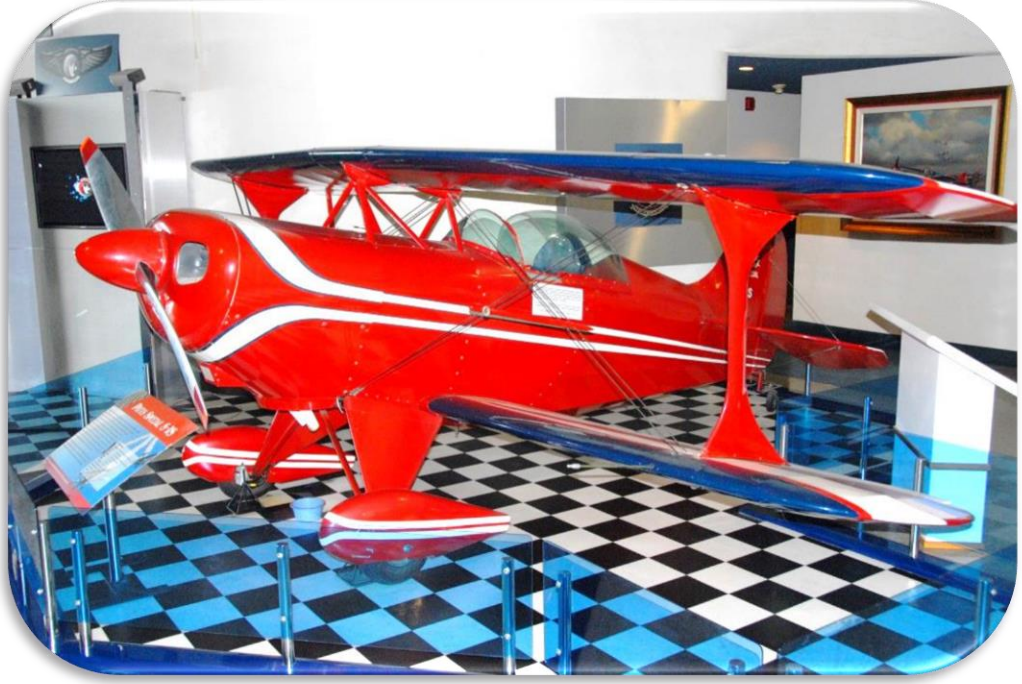

1st flight: 1944
(Number built ?
Best guess:
Hundreds)

Key Points: Pitts S-1S Special (**Original**). Curtiss Pitts, a crop duster and manager of a small airport, loved aerobatics. **1944, Pitts built his first Pitts Special**. **Pitts became standard for all aerobatic planes. Betty Skelton's "Little Stinker," won International Aerobatic Championships for Women in 1948, 1949 and 1950**. Official plane of the U.S. Aerobatic team for several years. Pitts Specials took most **U.S. National Aerobatic Championships from 1965 through 1980**. 1974 U.S. Aerobatic Team **won the "Grand Slam"** at World Championships, 1st Men's, 1st Women's & 1st Team, all using the Pitts Special.

This: 180 hp, 4 cylinder Lycoming engine, top speed 177. Manufacturer: Pitts Aviation, built by Harvey Short of Coronado, CA, in **1975**, painted in **Betty Skelton's paint scheme**, purchased by Museum in 1980.

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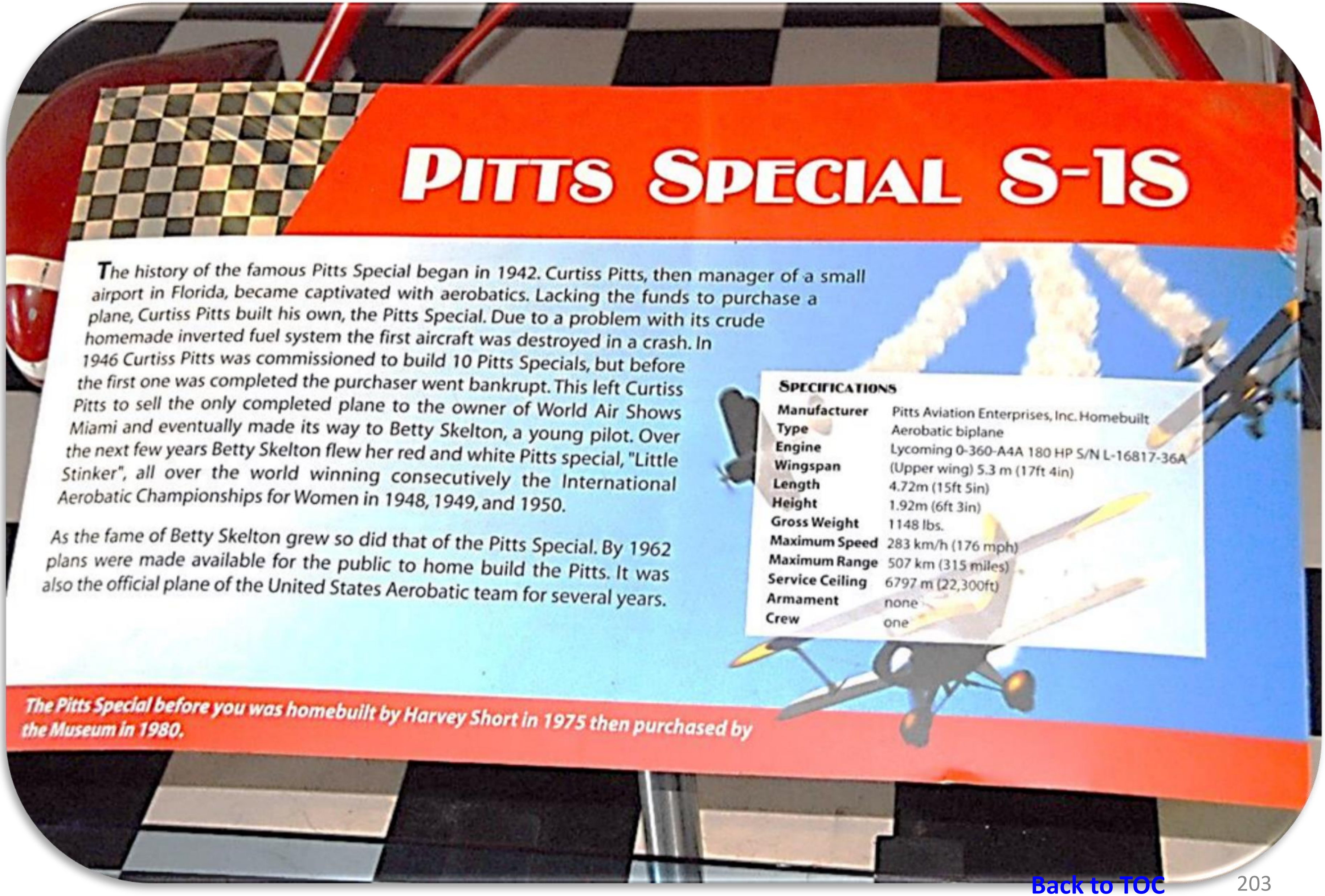

PITTS SPECIAL S-1S

The history of the famous Pitts Special began in 1942. Curtiss Pitts, then manager of a small airport in Florida, became captivated with aerobatics. Lacking the funds to purchase a plane, Curtiss Pitts built his own, the Pitts Special. Due to a problem with its crude homemade inverted fuel system the first aircraft was destroyed in a crash. In 1946 Curtiss Pitts was commissioned to build 10 Pitts Specials, but before the first one was completed the purchaser went bankrupt. This left Curtiss Pitts to sell the only completed plane to the owner of World Air Shows Miami and eventually made its way to Betty Skelton, a young pilot. Over the next few years Betty Skelton flew her red and white Pitts special, "Little Stinker", all over the world winning consecutively the International Aerobatic Championships for Women in 1948, 1949, and 1950.

As the fame of Betty Skelton grew so did that of the Pitts Special. By 1962 plans were made available for the public to home build the Pitts. It was also the official plane of the United States Aerobatic team for several years.

SPECIFICATIONS

Manufacturer	Pitts Aviation Enterprises, Inc. Homebuilt
Type	Aerobatic biplane
Engine	Lycoming 0-360-A4A 180 HP S/N L-16817-36A
Wingspan	(Upper wing) 5.3 m (17ft 4in)
Length	4.72m (15ft 5in)
Height	1.92m (6ft 3in)
Gross Weight	1148 lbs.
Maximum Speed	283 km/h (176 mph)
Maximum Range	507 km (315 miles)
Service Ceiling	6797 m (22,300ft)
Armament	none
Crew	one

The Pitts Special before you was homebuilt by Harvey Short in 1975 then purchased by the Museum in 1980.

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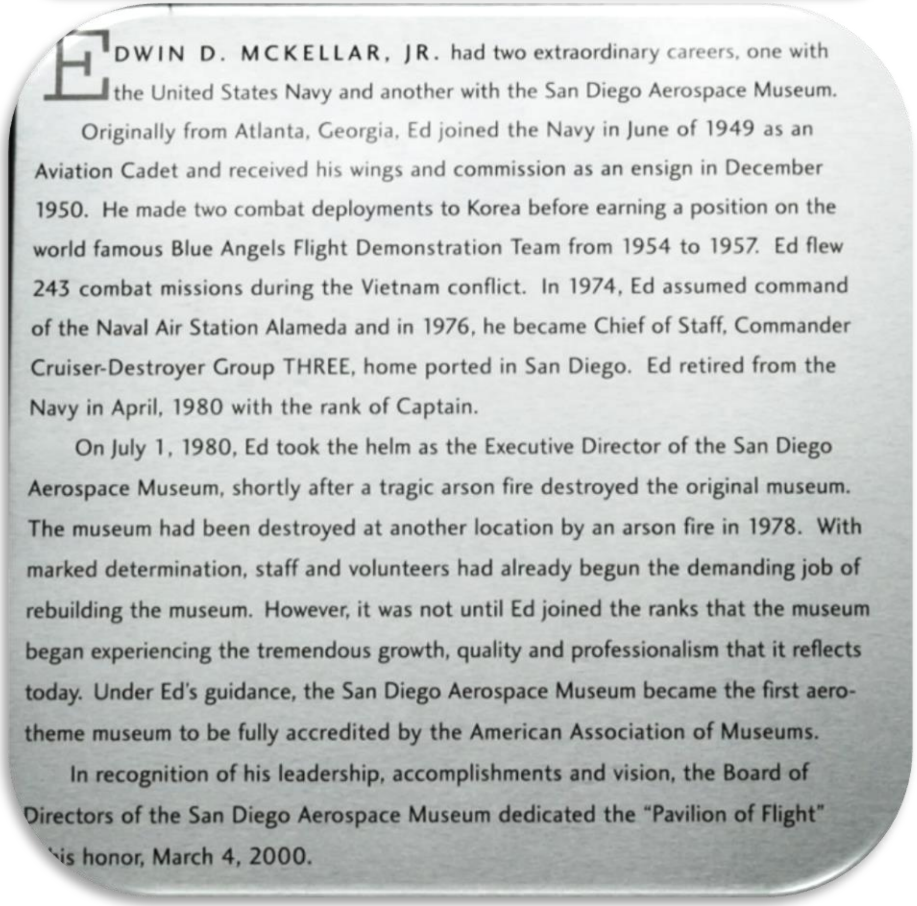
Pavilion Gallery

Key Points: **Edwin D McKellar Jr.** (Sep 14, 1928 – Aug 20, 2002)**,** In 1949, became a **Navy pilot** and ultimately completed **two Korea combat tours**, **243 Vietnam combat missions & 3 years with Blue Angles**. Commanded NAS Alameda and C-D Group 3 at San Diego. **Retired 1980 as a Navy Captain**. The same year, he **became the Executive Director San Diego Air & Space Museum** which achieved full accreditation by the **American Association of Museums** under his guidance. **Mar 4, 2000**, **Pavilion of Flight** dedicated in his honor.

Edwin D. McKellar, Jr.
Pavilion of Flight



EDWIN D. MCKELLAR, JR. had two extraordinary careers, one with the United States Navy and another with the San Diego Aerospace Museum.

Originally from Atlanta, Georgia, Ed joined the Navy in June of 1949 as an Aviation Cadet and received his wings and commission as an ensign in December 1950. He made two combat deployments to Korea before earning a position on the world famous Blue Angels Flight Demonstration Team from 1954 to 1957. Ed flew 243 combat missions during the Vietnam conflict. In 1974, Ed assumed command of the Naval Air Station Alameda and in 1976, he became Chief of Staff, Commander Cruiser-Destroyer Group THREE, home ported in San Diego. Ed retired from the Navy in April, 1980 with the rank of Captain.

On July 1, 1980, Ed took the helm as the Executive Director of the San Diego Aerospace Museum, shortly after a tragic arson fire destroyed the original museum. The museum had been destroyed at another location by an arson fire in 1978. With marked determination, staff and volunteers had already begun the demanding job of rebuilding the museum. However, it was not until Ed joined the ranks that the museum began experiencing the tremendous growth, quality and professionalism that it reflects today. Under Ed's guidance, the San Diego Aerospace Museum became the first aero-theme museum to be fully accredited by the American Association of Museums.

In recognition of his leadership, accomplishments and vision, the Board of Directors of the San Diego Aerospace Museum dedicated the "Pavilion of Flight" his honor, March 4, 2000.

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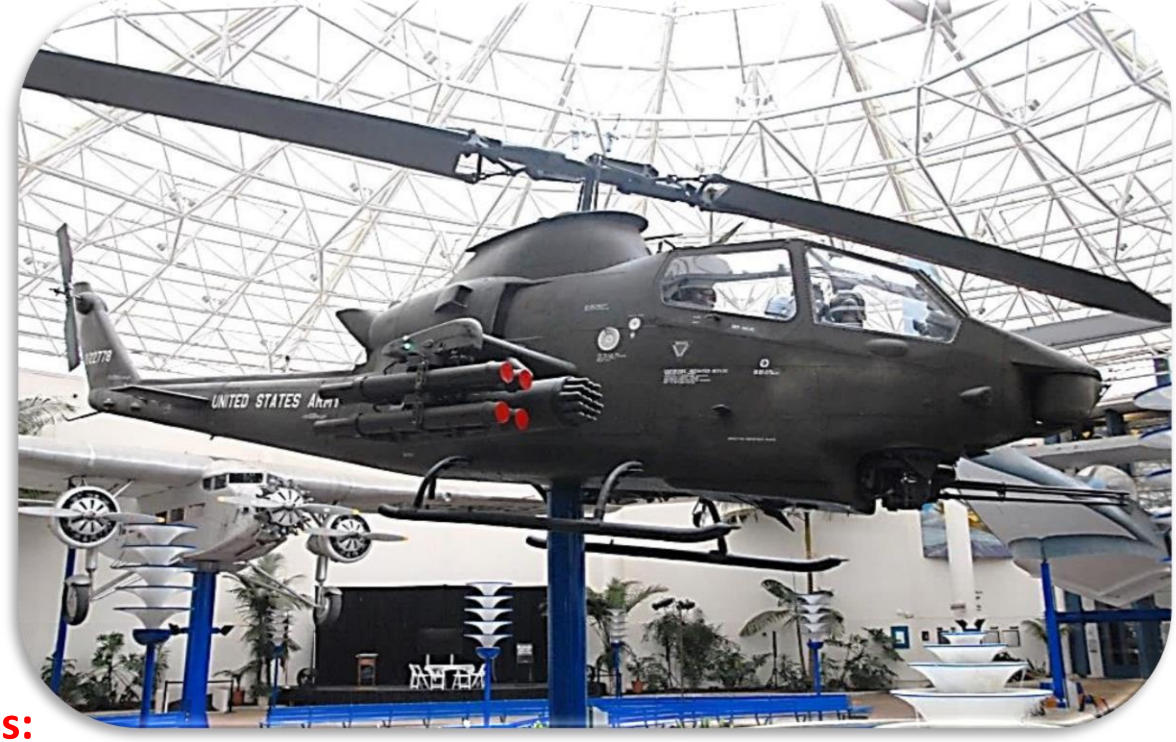
Pavilion Gallery



1st flight: 1967
(2200+ built)

Key Points:

Bell AH-1E Cobra Helicopter (**Original**). **World's first helicopter designed as an attack aircraft**. First action, **Vietnam, 1967**. **Used many proven components from UH-1 Huey**, to provide reliability and common supply chain availability**. Very survivable with narrow fuselage and armor protecting crew and vital components. Quick to rearm and refuel. Over 2200 produced**. Versions still in use by the Marine Corps. Engine: Lycoming T53-L-703 1800 hp, **max speed 190kts** (218mph).

This: AH-1E Cobra (enhanced AH-1S). **Built in 1977**, **action in Grenada 1983**, Last assigned to 7th Division, Fort Ord, CA. **Shown w/2.75" rockets, TOW anti-tank missiles and 20mm Vulcan cannon.** Donated by the U.S. Army in 1993.

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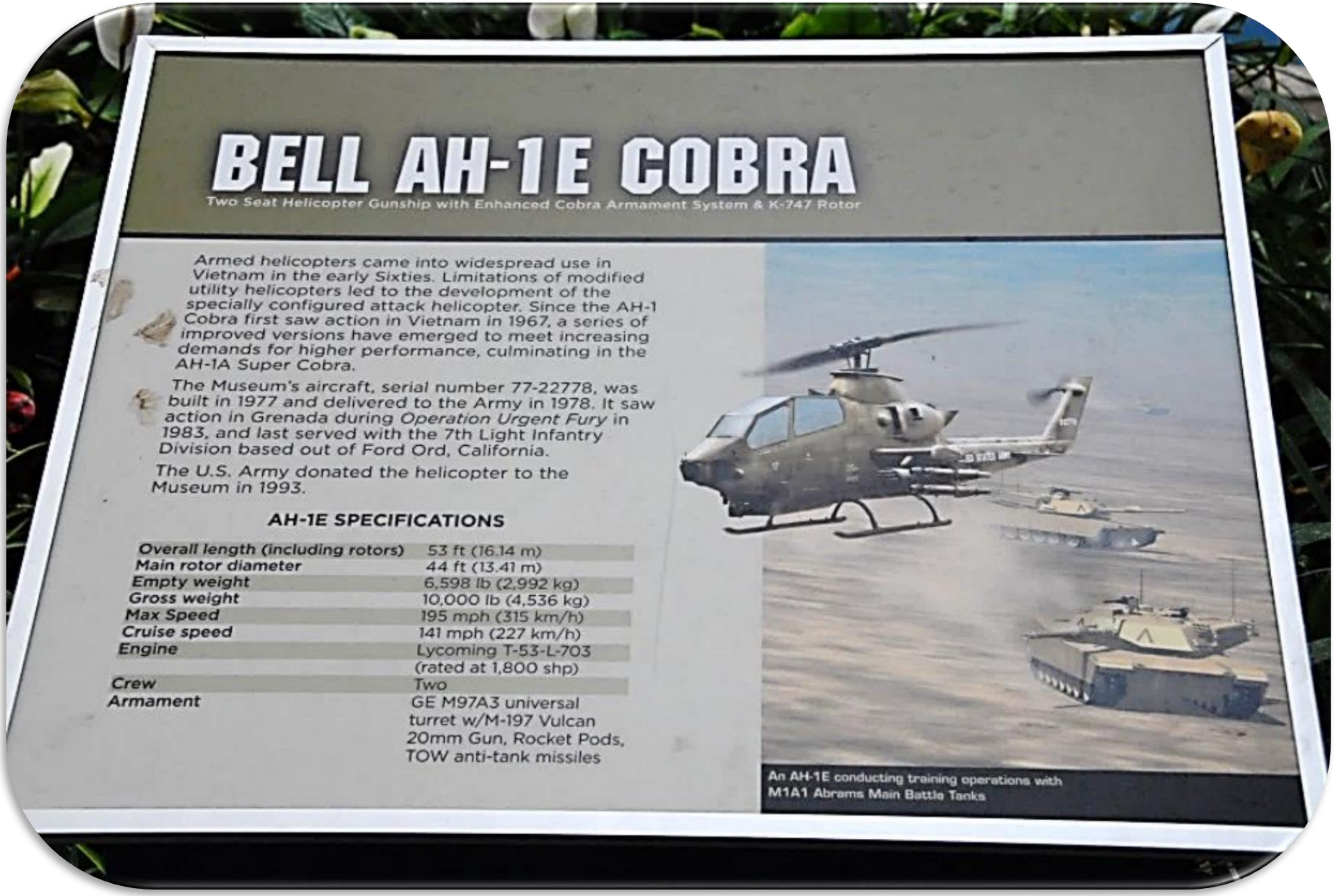
Pavilion Gallery



BELL AH-1E COBRA

Two Seat Helicopter Gunship with Enhanced Cobra Armament System & K-747 Rotor

Armed helicopters came into widespread use in Vietnam in the early Sixties. Limitations of modified utility helicopters led to the development of the specially configured attack helicopter. Since the AH-1 Cobra first saw action in Vietnam in 1967, a series of improved versions have emerged to meet increasing demands for higher performance, culminating in the AH-1A Super Cobra.

The Museum's aircraft, serial number 77-22778, was built in 1977 and delivered to the Army in 1978. It saw action in Grenada during *Operation Urgent Fury* in 1983, and last served with the 7th Light Infantry Division based out of Ford Ord, California.

The U.S. Army donated the helicopter to the Museum in 1993.

AH-1E SPECIFICATIONS

Overall length (including rotors)	53 ft (16.14 m)
Main rotor diameter	44 ft (13.41 m)
Empty weight	6,598 lb (2,992 kg)
Gross weight	10,000 lb (4,536 kg)
Max Speed	195 mph (315 km/h)
Cruise speed	141 mph (227 km/h)
Engine	Lycoming T-53-L-703 (rated at 1,800 shp)
Crew	Two
Armament	GE M97A3 universal turret w/M-197 Vulcan 20mm Gun, Rocket Pods, TOW anti-tank missiles

An AH-1E conducting training operations with M1A1 Abrams Main Battle Tanks

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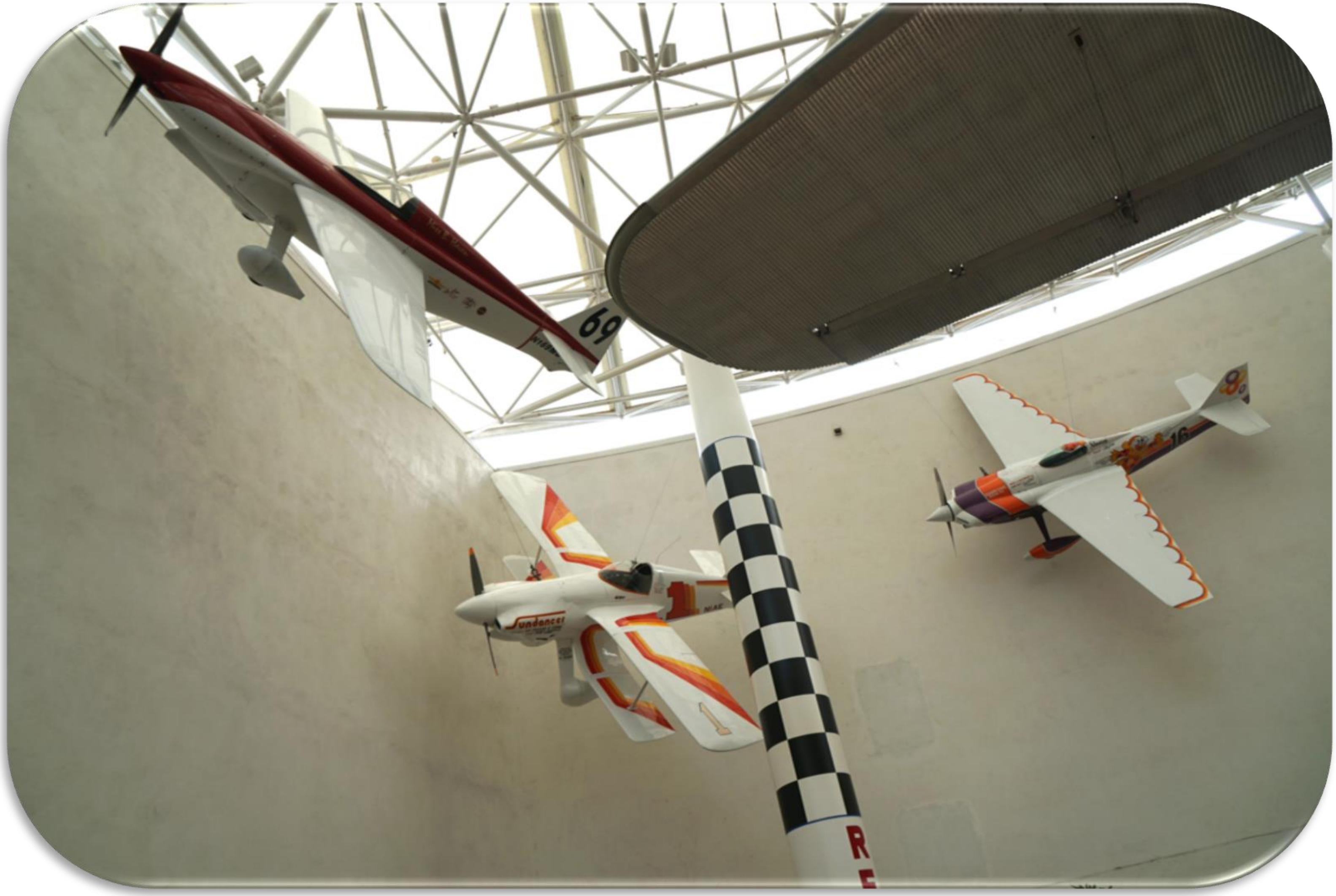
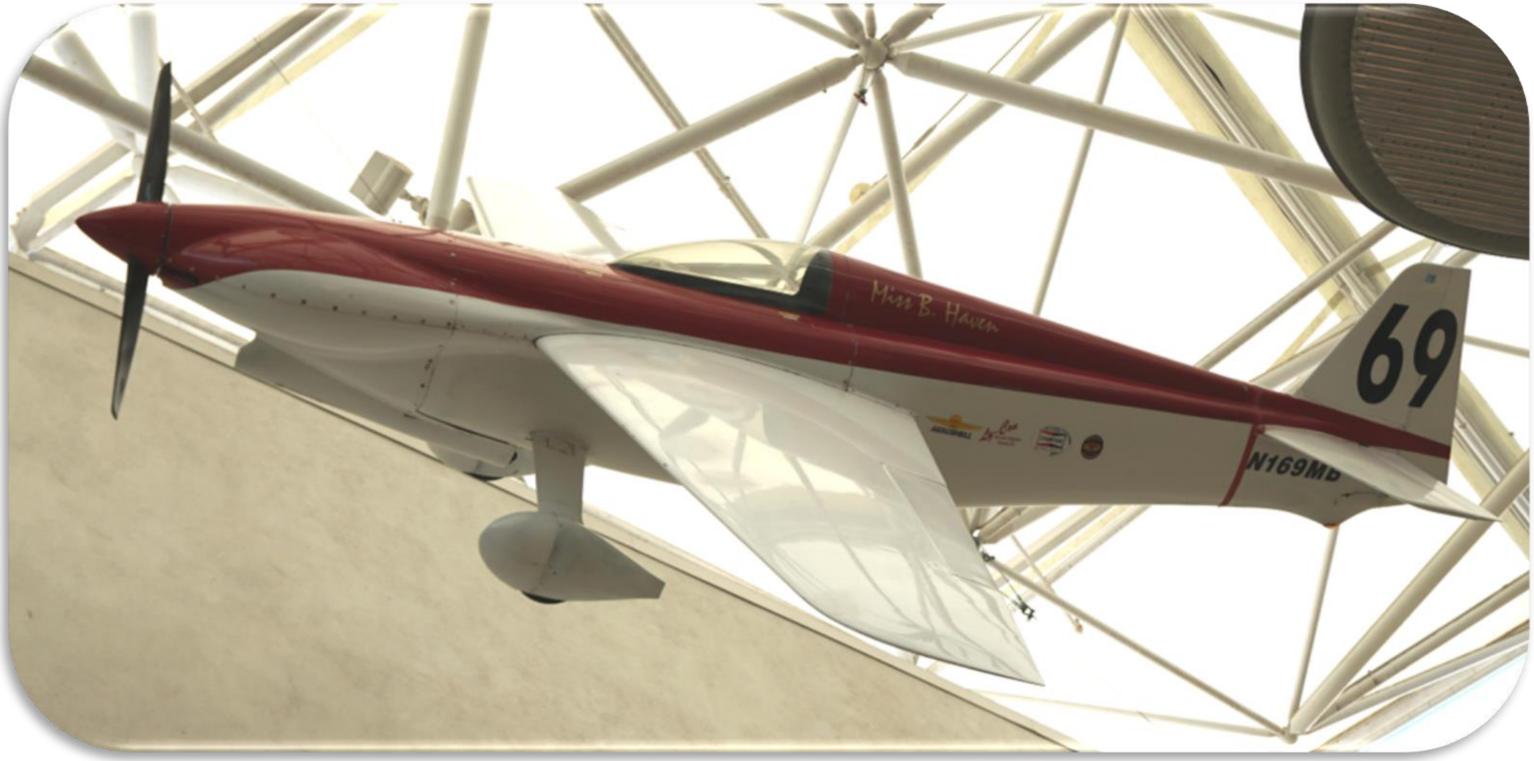

69
Sundancer
1
16

Formula 1 Midget Racers

Pavilion Gallery



Key Points: **"Miss B. Haven"** (**Original**) Constructed as a Monnett Sonerai II, that was originally called *Shadow*. It was built using the fuselage molds originally built for another aircraft. Original molds bought from Jon Sharp. Dan (?) used a much more conventional thin wing profile. It was a solid gold race airplane, but never really close to winning.

This: Unknown

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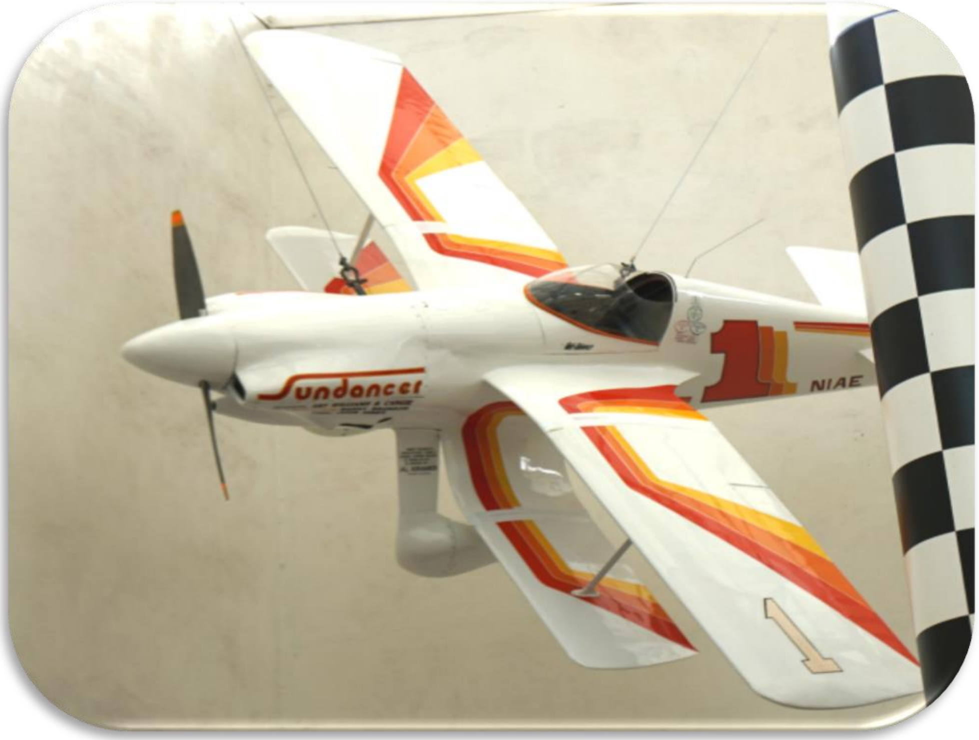

Key Points: **Williams-Cangie WC-1 “Sundancer”** (**Original**) N1AE, S/N 1, Homebuilt racing biplane designed by Art Williams & Carl Cangie. Built by Ralph Thenhaus in 1974. Only one was built. Features unusual biplane layout, upper wing just below the cockpit canopy and the lower gull wing mounted at the bottom of the fuselage. Single-seat enclosed cockpit with a bubble canopy & fixed conventional landing gear. Fuselage was derived from the Bushby Midget Mustang. Aircraft made from aluminum sheet, with flush riveted stressed skin. **On its first flight the WC-1 set a national class record of 194 mph. Was 6 times National Champion and World Record holder.**

This: Donated by Pat Hines of Encino, CA, and put on display 1987.

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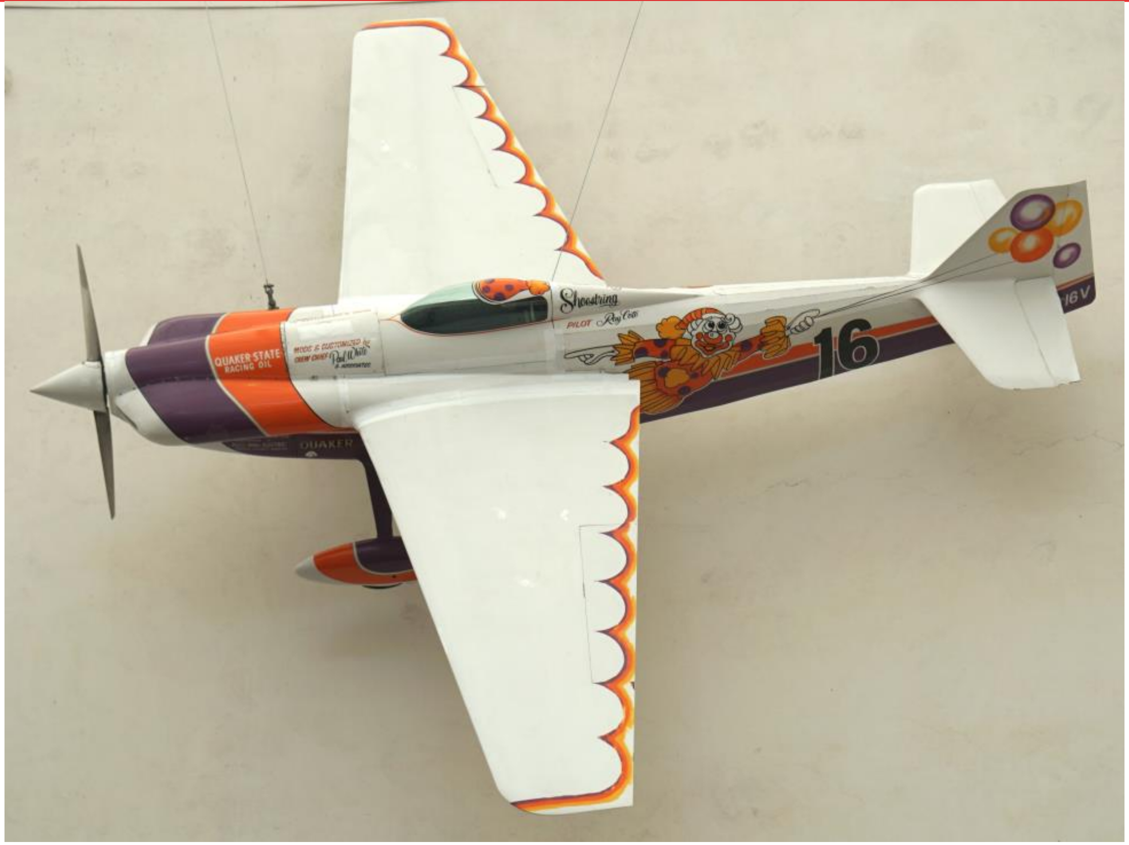

Key Points: **Custom Built International Formula 1 Midget Racer "Shoestring".** (Original) **Flew more races and had more victories than any racer in any class of racing**. 105 race entries from 1949 until 1981; **51, 1st place finishes**, set national speed record (1981) of 254.3 mph. Fourth owner, Ray Cote & family of El Cajon, raced Shoestring from 1966 until 1981, **won 40 out of 64 races** entered, including **9 National Championship titles**.

This: Donated by the Cote family to SDASM in 1982.

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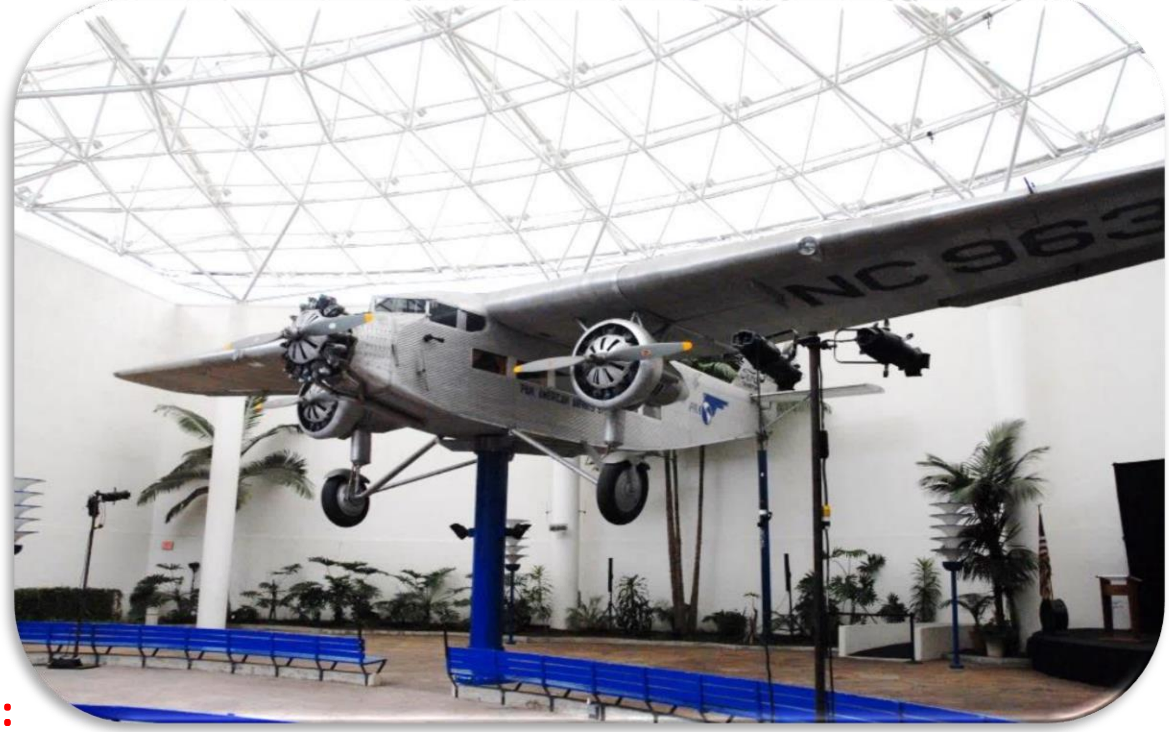

1st flight: 1925
(199 built)

Key Points:

Ford 5-AT-B Trimotor (**Original**). **1925**, Ford Motor Company, entered aircraft design and production with the "Tin Goose". The 4-AT equipped with three Wright Whirlwind engines, the **5-AT** had the more powerful **420 horsepower Pratt and Whitney Wasp engines**. Production began in **1926, by 1933, 199 Trimotors were produced. One the best safety records in the industry**. By **1929, Transcontinental Air Transport (later TWA) used Trimotor to inaugurate first regular coast to coast air service**. Military purchased Trimotors as transport aircraft. In 1929 **Commander Richard E. Byrd, successfully carried out the first flight to the South Pole** in a modified 4-AT, the ***Floyd Bennett***.

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Pavilion Gallery

Extra Info:

Crew: **3**
Pax: **11 to 17**
Cruise: **107 mph**
Range: 570 miles
Max Alt: 18,600
Design influenced by **Hugo Junkers G-24**.

Extra Info:

All metal exterior skin was corrugated to improve stiffness, however it also increased drag, reducing performance.

This:

Was the **eleventh, 5-AT** to come out of Ford's Dearborn, Michigan plant, purchased by **Pan American Airlines in 1928 for Miami to Cuba route & Brownsville to Mexico City route.** 1934, it was **sold to six different companies**, ending with **Scenic Airlines of Las Vegas for air tours over the Grand Canyon and Las Vegas Strip**. This Trimotor has logged **24,043 hours** of flight time. The Trimotor was then **donated by Scenic Airlines to the San Diego Air & Space Museum in August of 1983**. Tim Cunningham and the restoration volunteers spent **nearly fifteen ye**ars, and tens of thousands of hours **restoring it** to its present condition.

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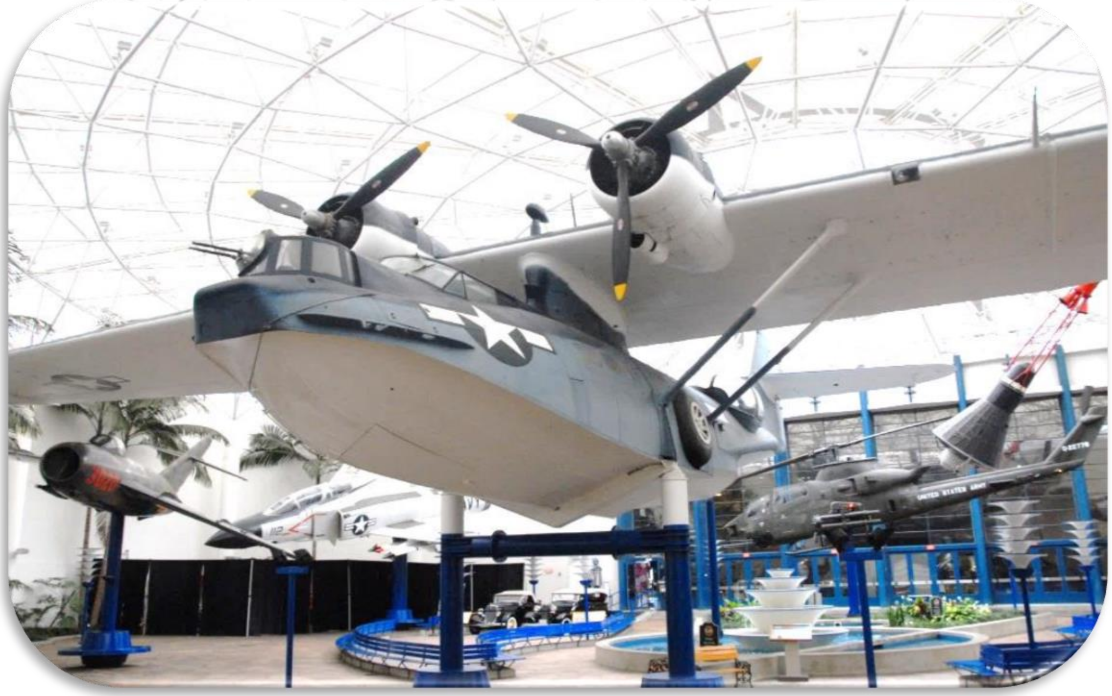
Pavilion Gallery



1st flight: 1935
(4000+ built)

Key Points:

Consolidated PBY-5A Catalina (Original). Most versatile of all flying boats. **1936 to 1945**, **over 4,000 Catalina's** built in **San Diego** & Canada. **1941, added landing gear** (amphibious) became PBY-5A and **most produced variant**. **Scouting, anti-submarine, rescue, logistics roles, night attacks on Japanese supply convoys, Black Cat operations**. Could be armed with **2000 lbs of bombs, depth charges or torpedoes**. **Sank 112,700 tons** of merchant shipping, **damaged another 47,000 tons** and sunk at least **10 Japanese warships** between August 1943 and January 1944.

This: Built by **San Diego Consolidated, delivered December 31, 1943**. **1,985th Catalina built**. Assigned to **Johnston Island (Pacific) to patrol the Gilbert and Marshall islands**. **Used by the Coast Guard until 1956**. Donated 1986.

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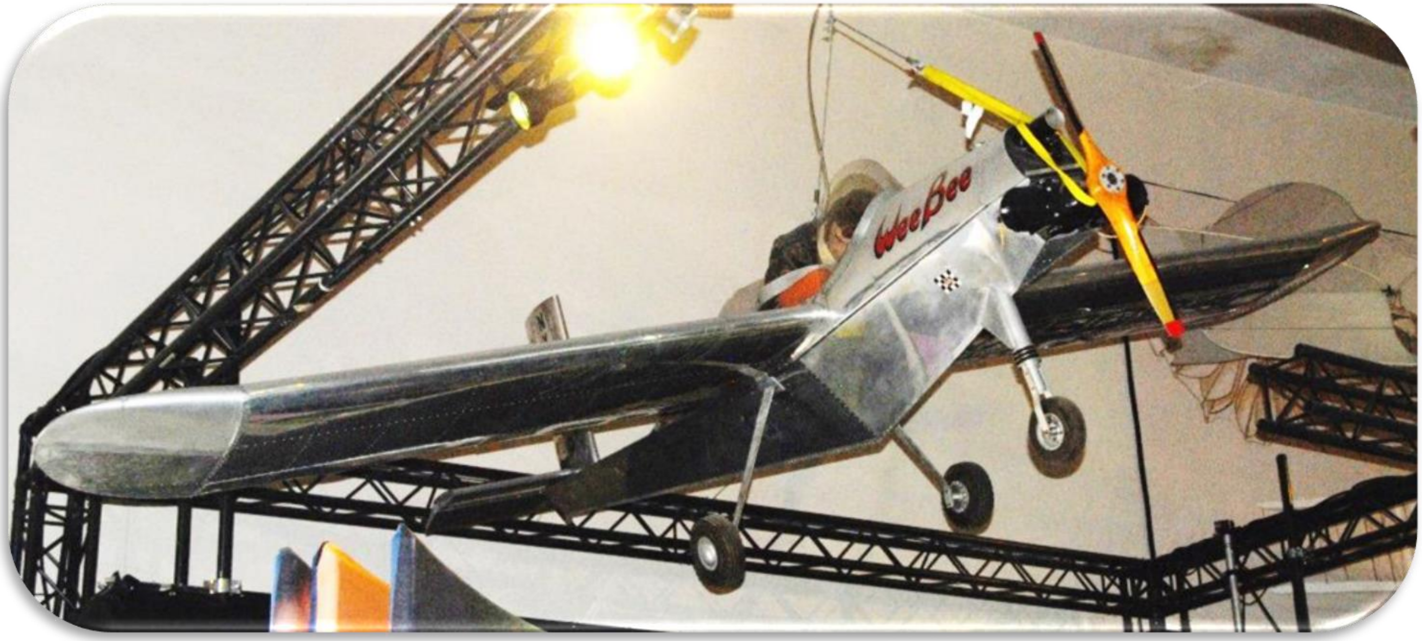

1st flight: 1948
(1 built)

Key Points: **Bee Aviation "Wee Bee"** (Replica). **1948**, three Consolidated engineers: Ken Coward, Bill Chana and Karl Montijo, designed and built this tiny aircraft.
1949, Flew at Sky Rodeo at Brown Field, CA. On tour, **Gatwick Air Pageant (London), Cleveland Air Races**. Final flight 1950. Static display at air shows. One **30 hp** 2 cylinder air cooled Kiekhaefer engine. Max speed **82 mph**.
This: The **original Wee Bee** was destroyed in the 1978 Museum fire, this flyable replica built in April 1978.

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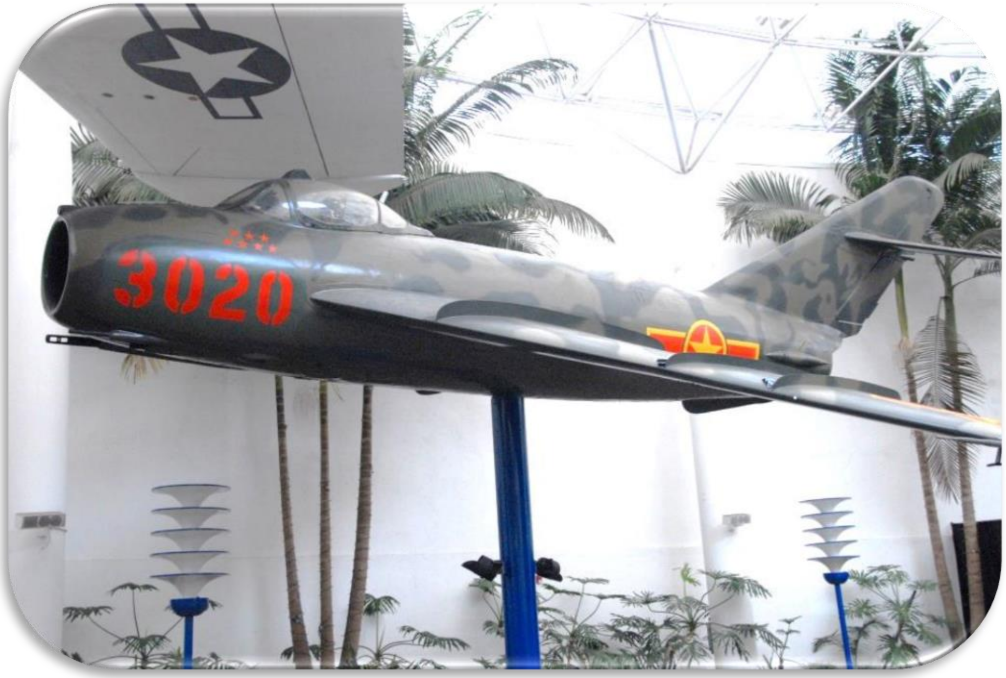

1st flight: 1951
(8000+ built)

Note: The MiG-17 carried **no missiles** or **rockets**, they used two 23mm and one 37mm **cannon**.

Quick ID

MiG 15 – **2** Wing Fences.
MiG 17 – **3** Wing Fences.

Key Points: **Mikoyan-Gurevich MiG-17F** (**Original**). Production started late 1951. **Early MiG-17 models day fighters; no afterburners, no radar, small airbrakes and sub-sonic**. Later mission was extended to night fighting. **MiG-17 became standard equipment for Warsaw Pact countries**. One of most widely produced, **over 8,000**. **Turned tighter than American jets**. **MiG-17 highlighted need for improved US tactics**, Navy and Air Force then established **Top Gun** and **Red Flag** tactics training programs.
This: Believed built in **Poland**. Served in the East German Air Force, transferred to the Egyptian Air Force. It was retired by Egyptians in late 70s or 80s. Purchased March 1986. **Paint scheme represents the North Vietnamese Air Force**, circa 1972.

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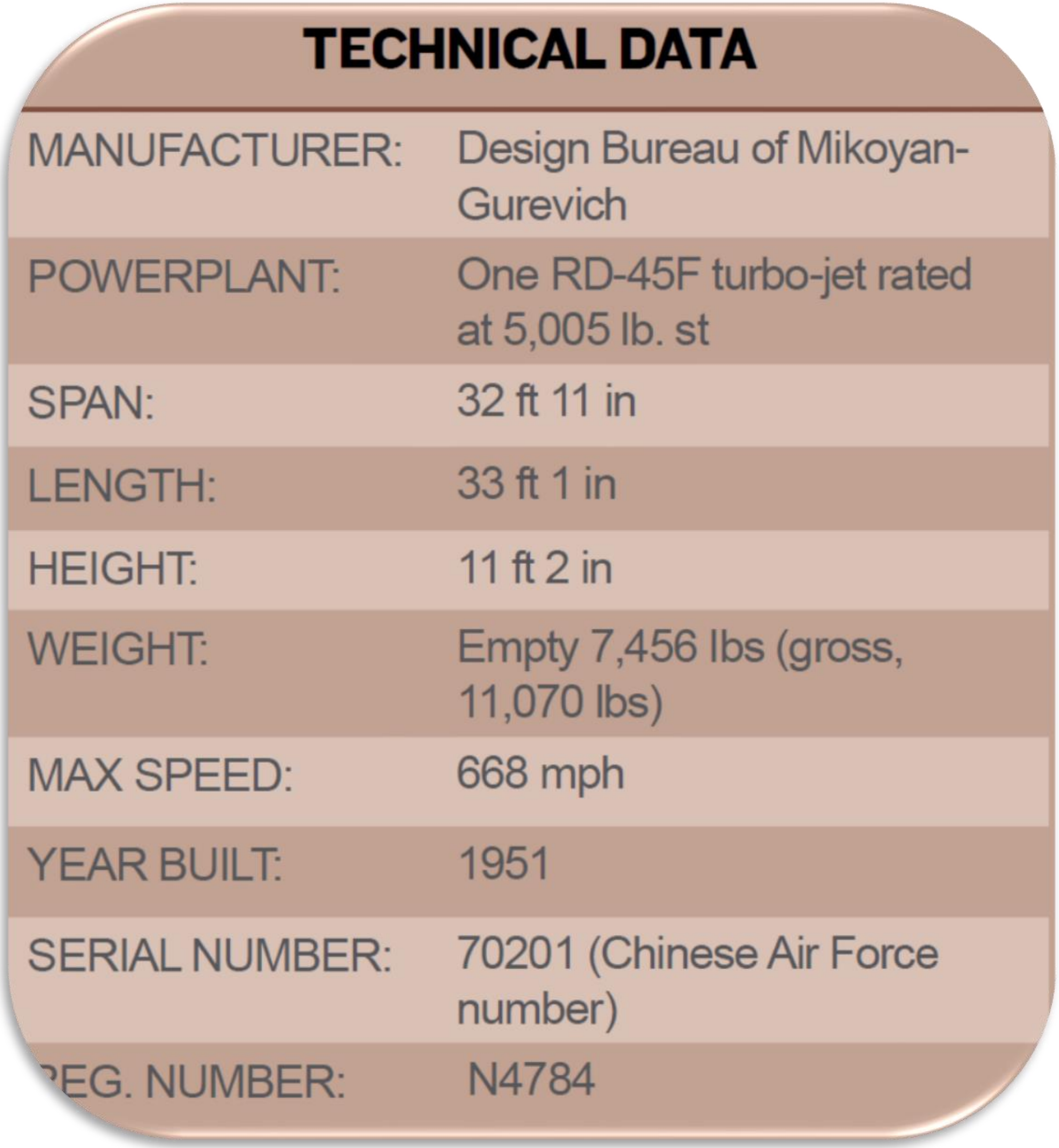
MiG-17



TECHNICAL DATA

MANUFACTURER:	Design Bureau of Mikoyan-Gurevich
POWERPLANT:	One RD-45F turbo-jet rated at 5,005 lb. st
SPAN:	32 ft 11 in
LENGTH:	33 ft 1 in
HEIGHT:	11 ft 2 in
WEIGHT:	Empty 7,456 lbs (gross, 11,070 lbs)
MAX SPEED:	668 mph
YEAR BUILT:	1951
SERIAL NUMBER:	70201 (Chinese Air Force number)
REG. NUMBER:	N4784

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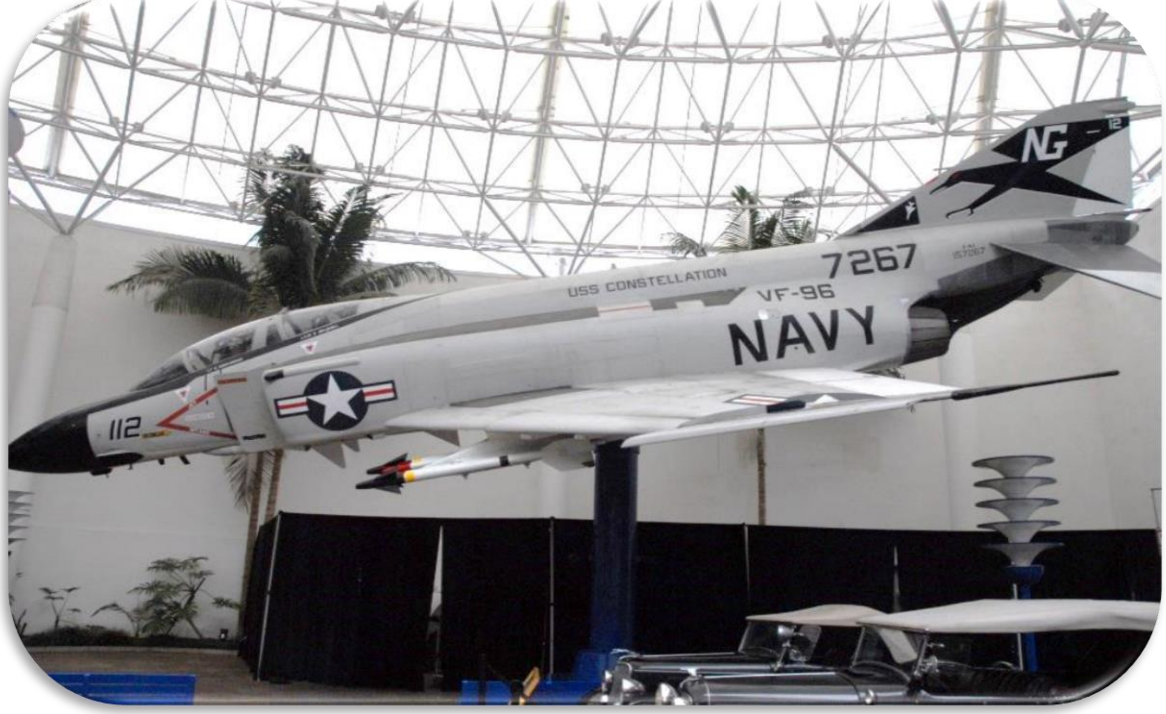
Pavilion Gallery



1st flight: 1960
(5200+ built)

Note: The F-4 carried **no internal cannon**, used assortment of external **missiles:**

- AIM-4 Falcon,
- **AIM-7 Sparrow,**
- **AIM-9 Sidewinder,**

(AIM-7 & 9 on display)

Later a **20 mm external** belly **canon pod** was added.

Key Points:

McDonnell Douglas F-4 Phantom II (**Original**). **The most versatile and popular jet fighter ever built.** **1960 to 1998 (38 years), over 5,200 aircraft built**. Scored **320+ victories**. Distinguished service Vietnam War & Desert Storm. Over 800 still flying for other nations. **First aircraft to fly w/USN, USMC & USAF**. **First to fly with ten nations**. **Only jet used by both Thunderbirds and Blue Angles**.

This: Fighter Squadron 96 "Fighting Falcons", USS Constellation. **1972, Lt. Randy "Duke" Cunningham & RIO Willie Driscoll**, Navy's **first aces of Vietnam, downed two MiGs in this aircraft** and three more MiG's in a similar F-4. 1988, retired, **painted as it was in 1972**, flying missions over the South China Sea and Vietnam.

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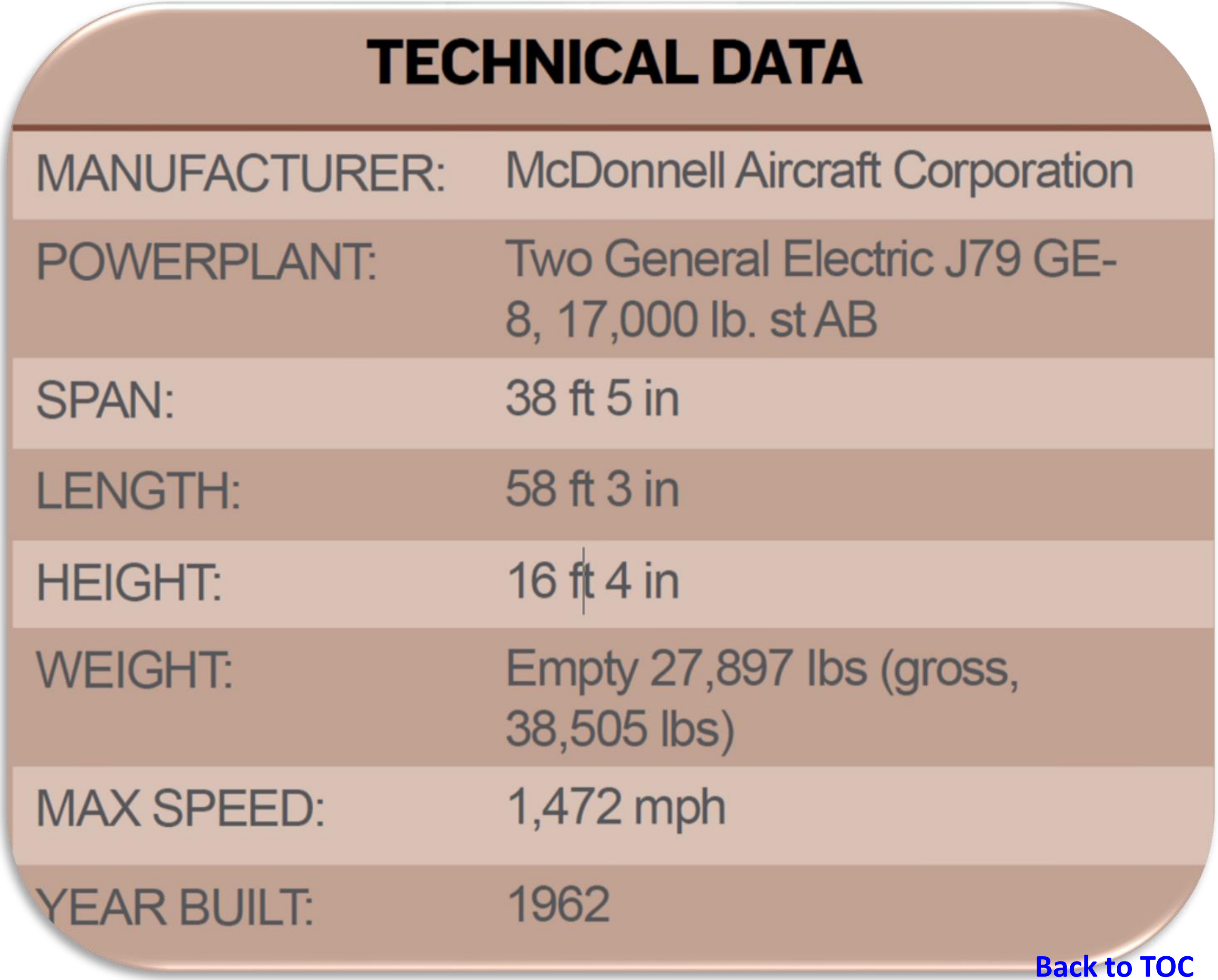
F-4 Phantom II



TECHNICAL DATA

MANUFACTURER:	McDonnell Aircraft Corporation
POWERPLANT:	Two General Electric J79 GE-8, 17,000 lb. st AB
SPAN:	38 ft 5 in
LENGTH:	58 ft 3 in
HEIGHT:	16 ft 4 in
WEIGHT:	Empty 27,897 lbs (gross, 38,505 lbs)
MAX SPEED:	1,472 mph
YEAR BUILT:	1962

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World War II Gallery

1939 thru 1945

The Tuskegee Airmen

1941 to 1945
(Approx. 16,000 ground and flight crews total)

45
Rearwi
EXIT
BLACK WINGS

Key Points:

"Tuskegee Airmen", African-American military pilots (996 pilots, 15K ground & flight crews [for both fighters and bombers]) **who fought in World War II, 1941 - 1945**. 332nd Fighter Group and the 477th Bombardment Group. **99th Pursuit Squadron, 1st black flying squadron & 1st overseas** (North Africa in April 1943, to Sicily and Italy). Flew **P-40 Warhawk**, **P-39 Airacobras** (March 1944), **P-47 Thunderbolts** (June–July 1944), and **P-51 Mustang** (July 1944). **Painted the tails of their P-47s and P-51s red, and the nickname "Red Tails" was coined.**

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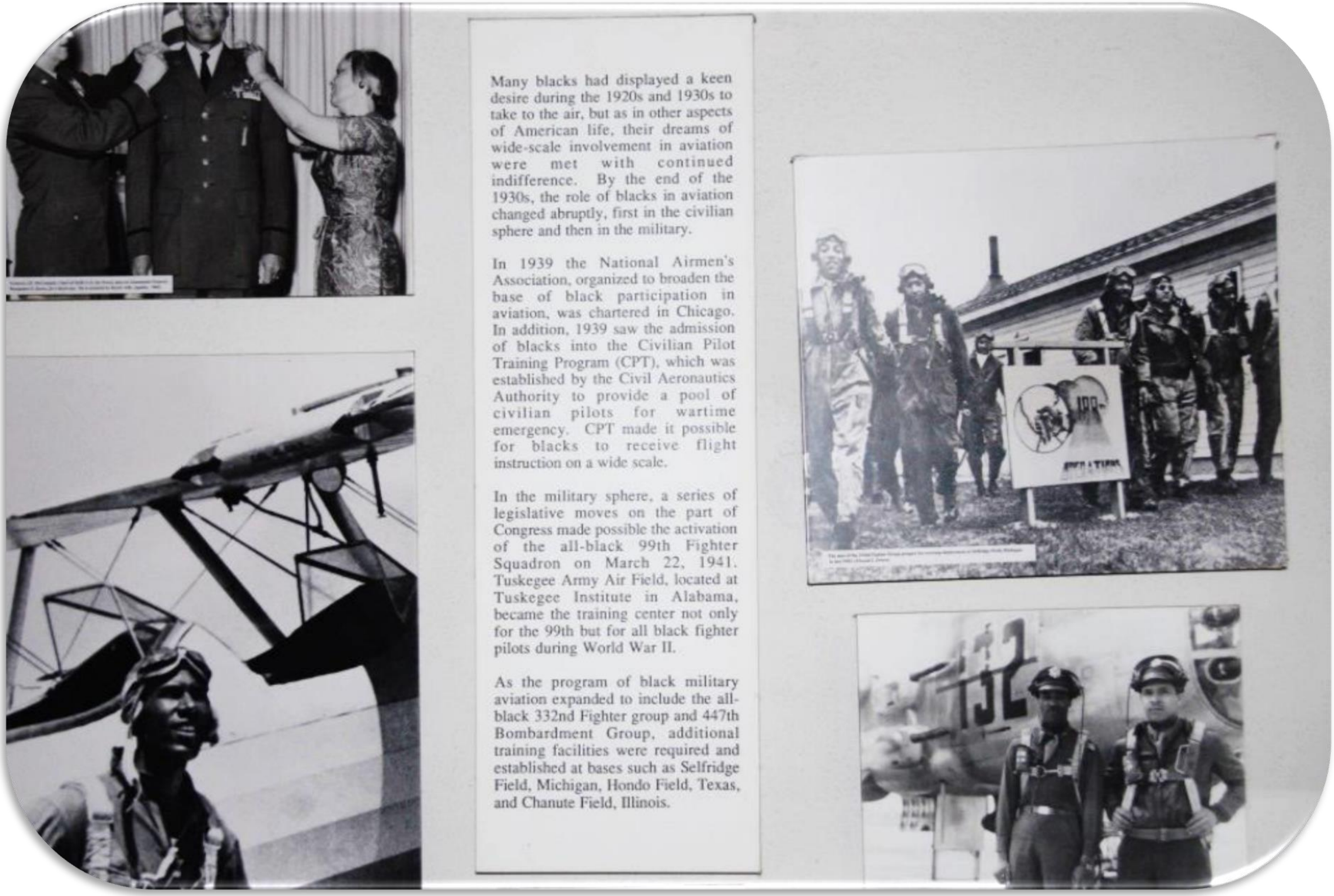
World War II Gallery



Many blacks had displayed a keen desire during the 1920s and 1930s to take to the air, but as in other aspects of American life, their dreams of wide-scale involvement in aviation were met with continued indifference. By the end of the 1930s, the role of blacks in aviation changed abruptly, first in the civilian sphere and then in the military.

In 1939 the National Airmen's Association, organized to broaden the base of black participation in aviation, was chartered in Chicago. In addition, 1939 saw the admission of blacks into the Civilian Pilot Training Program (CPT), which was established by the Civil Aeronautics Authority to provide a pool of civilian pilots for wartime emergency. CPT made it possible for blacks to receive flight instruction on a wide scale.

In the military sphere, a series of legislative moves on the part of Congress made possible the activation of the all-black 99th Fighter Squadron on March 22, 1941. Tuskegee Army Air Field, located at Tuskegee Institute in Alabama, became the training center not only for the 99th but for all black fighter pilots during World War II.

As the program of black military aviation expanded to include the all-black 332nd Fighter group and 447th Bombardment Group, additional training facilities were required and established at bases such as Selfridge Field, Michigan, Hondo Field, Texas, and Chanute Field, Illinois.

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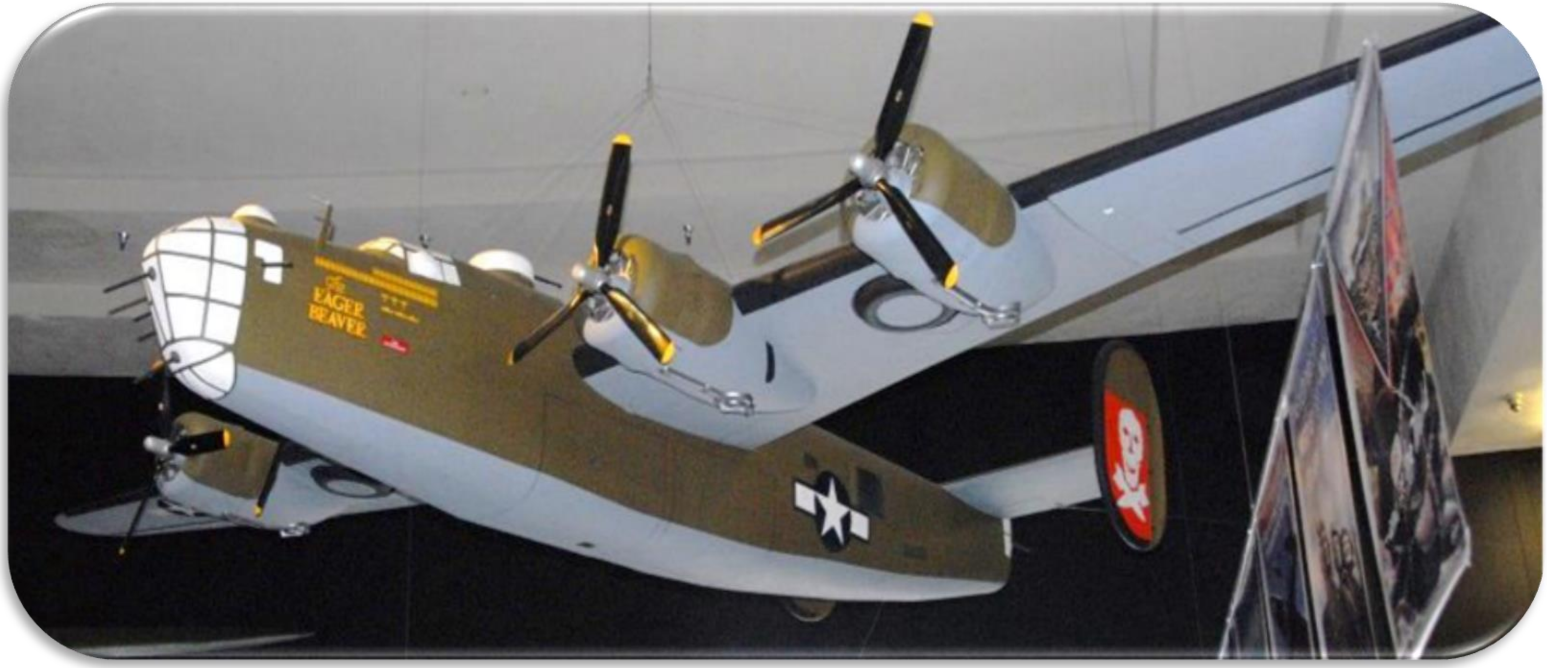
World War II Gallery



1^{st} flight: 1939
(18,482 Built)

Key Points: **B-24D-7-C0 Liberator** (Model). An American heavy bomber. 1939 - 1945, B-24s designed and built by Consolidated Aircraft in San Diego, CA. Compared with the B-17, the B-24 had more modern design (**high aspect ratio 'Davis' wing**), **higher top speed**, **greater range**, **heavier bomb load**, but **lower operational ceiling** (only 28,000), **difficult to fly** and **notoriously caught fire** (fuel manifolds converged above bomb bay, enemy fighters aimed there). **B-24 most produced US combat aircraft during WWII, at 18,482 aircraft**. USAF, Navy, RAF, RCAF, RAAF all flew B-24's. Armed with up to **10** each **.50 caliber machine guns** and cruising at 215 mph, the B-24 had a **combat range of 2100 miles or** nearly **10 hours of flight**.

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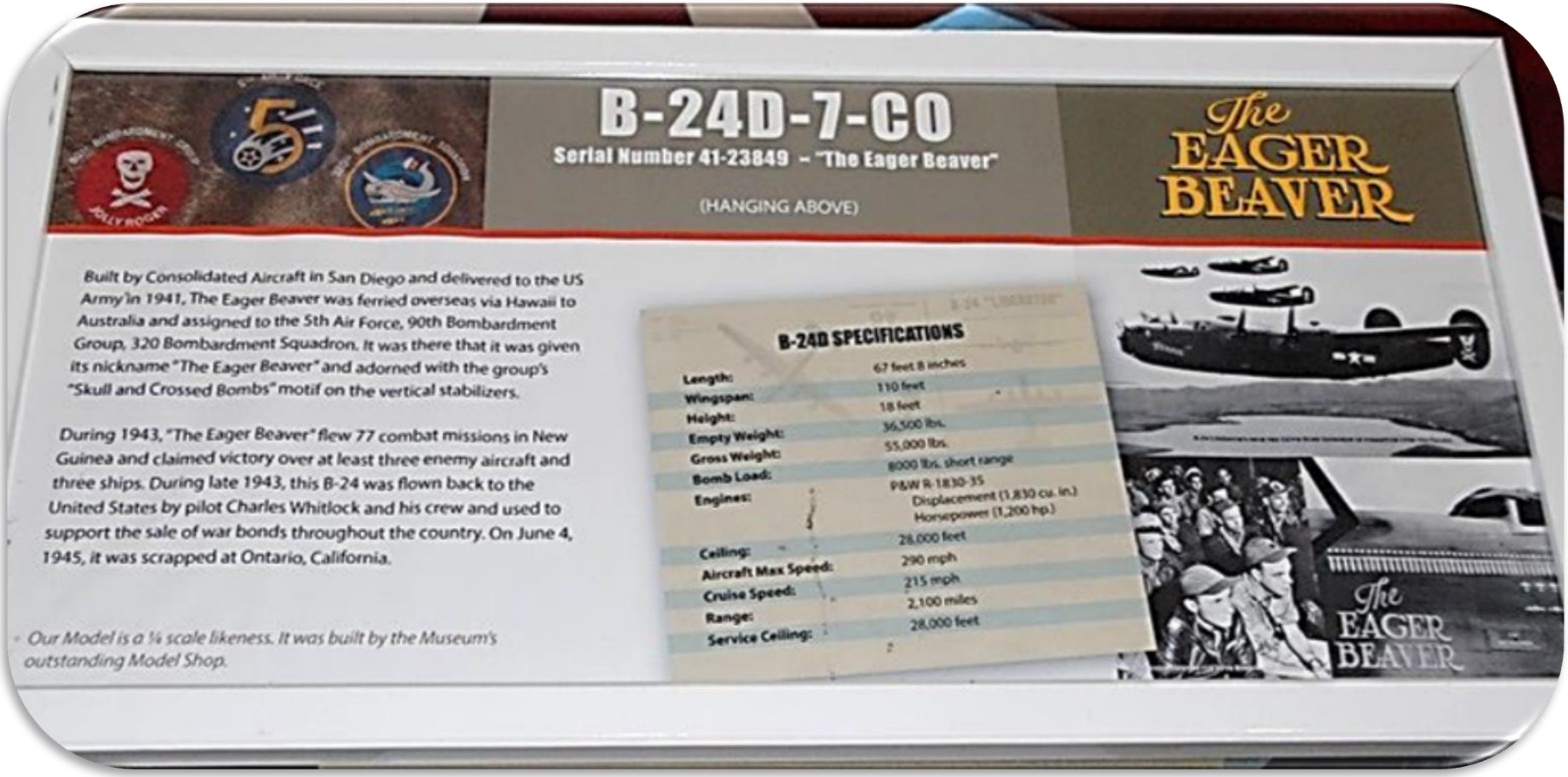
World War II Gallery



B-24D-7-CO

Serial Number 41-23849 – "The Eager Beaver"

(HANGING ABOVE)

The EAGER BEAVER

Built by Consolidated Aircraft in San Diego and delivered to the US Army in 1941, The Eager Beaver was ferried overseas via Hawaii to Australia and assigned to the 5th Air Force, 90th Bombardment Group, 320 Bombardment Squadron. It was there that it was given its nickname "The Eager Beaver" and adorned with the group's "Skull and Crossed Bombs" motif on the vertical stabilizers.

During 1943, "The Eager Beaver" flew 77 combat missions in New Guinea and claimed victory over at least three enemy aircraft and three ships. During late 1943, this B-24 was flown back to the United States by pilot Charles Whitlock and his crew and used to support the sale of war bonds throughout the country. On June 4, 1945, it was scrapped at Ontario, California.

Our Model is a ¼ scale likeness. It was built by the Museum's outstanding Model Shop.

B-24D SPECIFICATIONS

Length:	67 feet 8 inches
Wingspan:	110 feet
Height:	18 feet
Empty Weight:	36,500 lbs.
Gross Weight:	55,000 lbs.
Bomb Load:	8000 lbs. short range
Engines:	P&W R-1830-35 Displacement (1,830 cu. in.) Horsepower (1,200 hp.)
Ceiling:	28,000 feet
Aircraft Max Speed:	290 mph
Cruise Speed:	215 mph
Range:	2,100 miles
Service Ceiling:	28,000 feet

This Model: Reproduction of aircraft 41-23849 which was assigned to the 320th Bombardment Squadron. Nicknamed "***The Eager Beaver***" with the group's "skull and crossed bombs" motif on the tail. 1943, the Eager Beaver **flew 77 combat missions** in New Guinea and claimed **three enemy fighters and three ships**. November 1943, flown back to U.S. by Charles P Whitlock. *The Eager Beaver* B-24 was **used during a war bond drive**. On June 4, 1945, it was scrapped at Ontario, CA.

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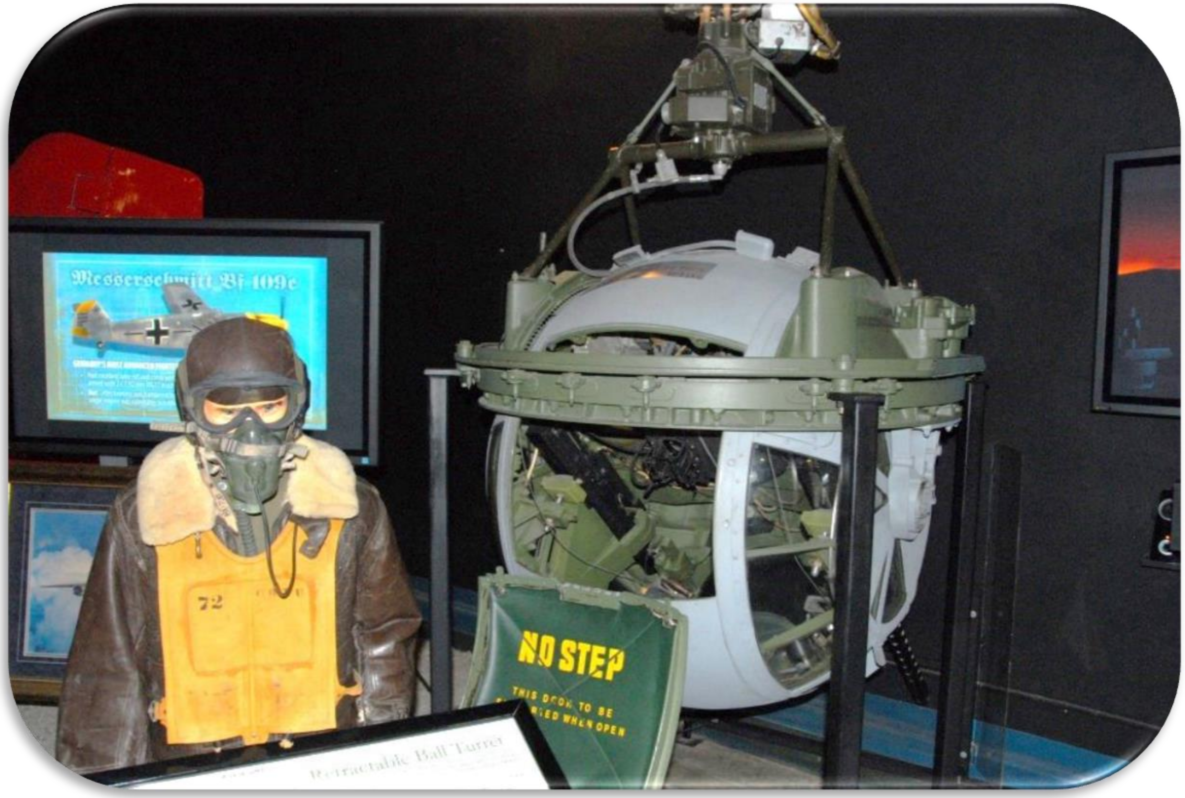
Messerschmitt Bf 109e
72
NO STEP
THIS DOOR TO BE ... WHEN OPEN
Retractable Ball Turret

1st used: 1942

Key Points: **Retractable Ball Turret** (**Original B-24 version**). The bottom gunner turret on the B-24 **retracted for takeoff and landing** due to limited ground clearance from the runway. The turret held **the gunner, two heavy machine guns, ammunition, and sights**. The turret was very small and any air crewman under 5’ 4” was subject to being assigned to the B-24 ball turret. The same ball turret was used on the B-17, however ground clearance was not a problem, so they were fixed rather than retractable turrets.

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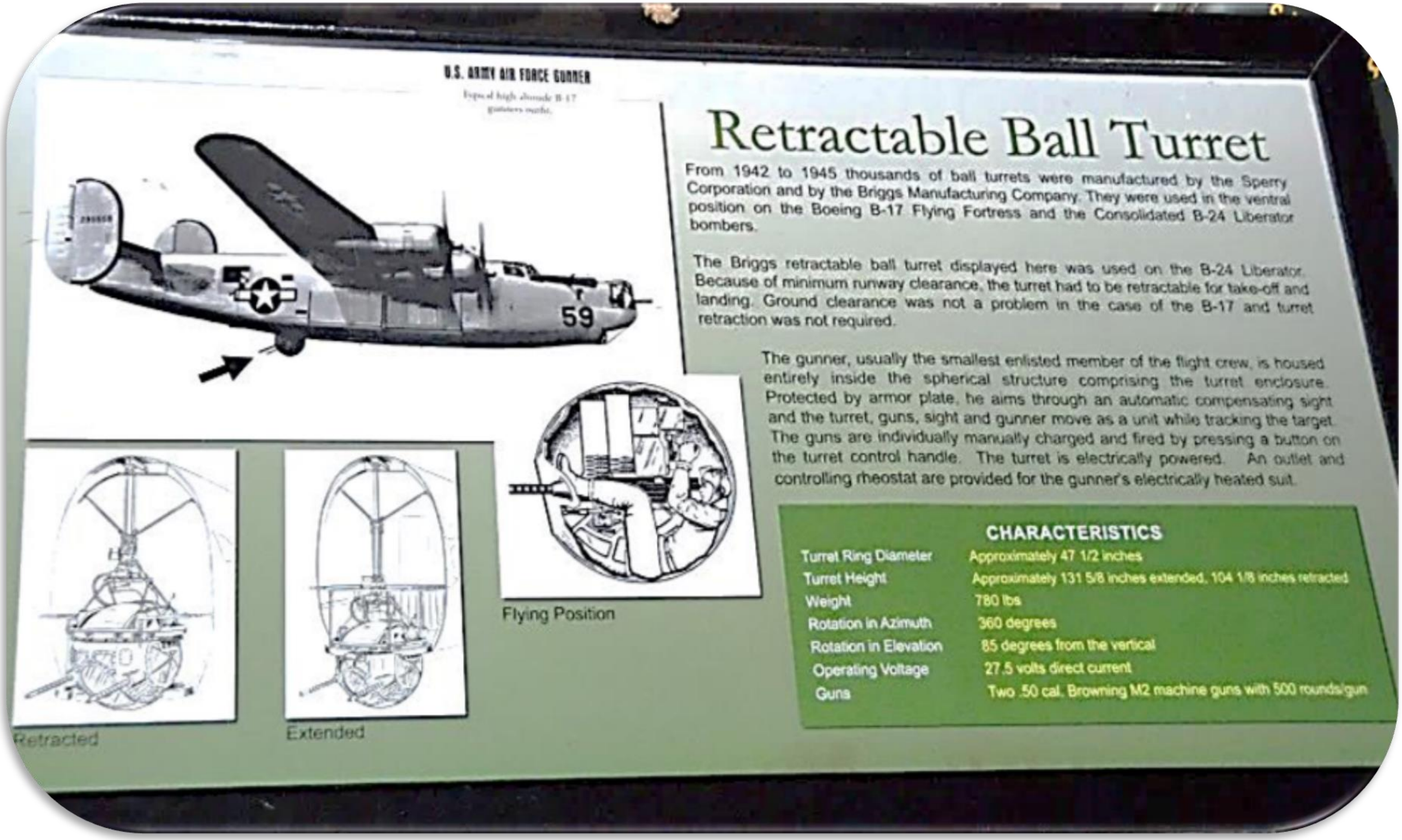
World War II Gallery



U.S. ARMY AIR FORCE GUNNER
Typical high altitude B-17 gunners outfit.
59

Retractable Ball Turret

From 1942 to 1945 thousands of ball turrets were manufactured by the Sperry Corporation and by the Briggs Manufacturing Company. They were used in the ventral position on the Boeing B-17 Flying Fortress and the Consolidated B-24 Liberator bombers.

The Briggs retractable ball turret displayed here was used on the B-24 Liberator. Because of minimum runway clearance, the turret had to be retractable for take-off and landing. Ground clearance was not a problem in the case of the B-17 and turret retraction was not required.

The gunner, usually the smallest enlisted member of the flight crew, is housed entirely inside the spherical structure comprising the turret enclosure. Protected by armor plate, he aims through an automatic compensating sight and the turret, guns, sight and gunner move as a unit while tracking the target. The guns are individually manually charged and fired by pressing a button on the turret control handle. The turret is electrically powered. An outlet and controlling rheostat are provided for the gunner's electrically heated suit.

CHARACTERISTICS

Turret Ring Diameter	Approximately 47 1/2 inches
Turret Height	Approximately 131 5/8 inches extended, 104 1/8 inches retracted
Weight	780 lbs
Rotation in Azimuth	360 degrees
Rotation in Elevation	85 degrees from the vertical
Operating Voltage	27.5 volts direct current
Guns	Two .50 cal. Browning M2 machine guns with 500 rounds/gun

Flying Position

Retracted

Extended

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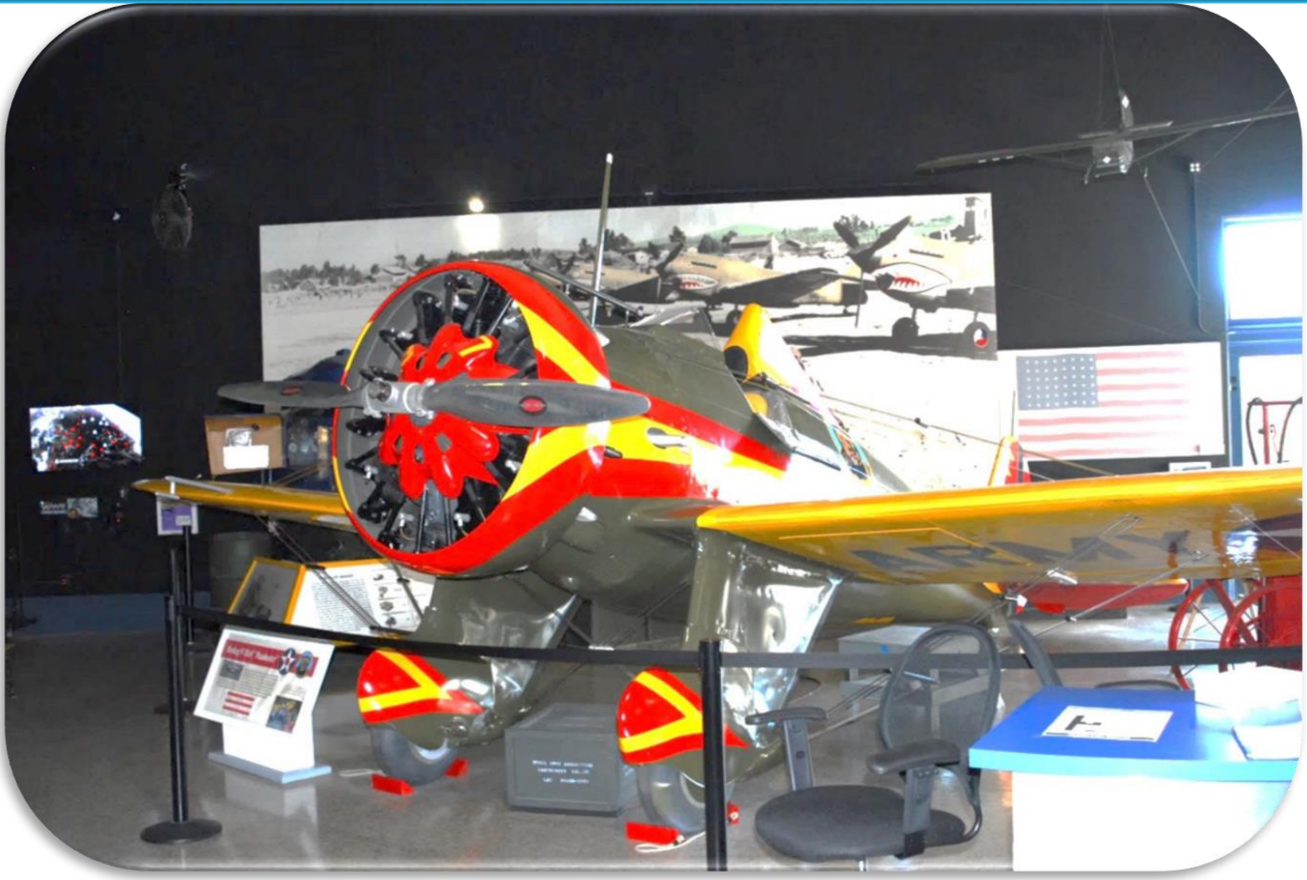
World War II Gallery



1st flight: 1932
(151 built)

Key Points:

Boeing P-26 Peashooter (Reproduction) Army Air Corps **1st monoplane** and **1st all metal aircraft**; military's transition aircraft from fabric. **First flew in 1932,** and was innovative, agile and effective, but was **obsolete by start of WWII**. It was the **last fighter plane** with **fixed gear and open cockpit**. 600 horsepower Pratt & Whitney R-1340 engine, top speed of 234 mph, both 30 caliber and 50 caliber machine guns.

This: **Eleven year** building project by SDAM volunteers.

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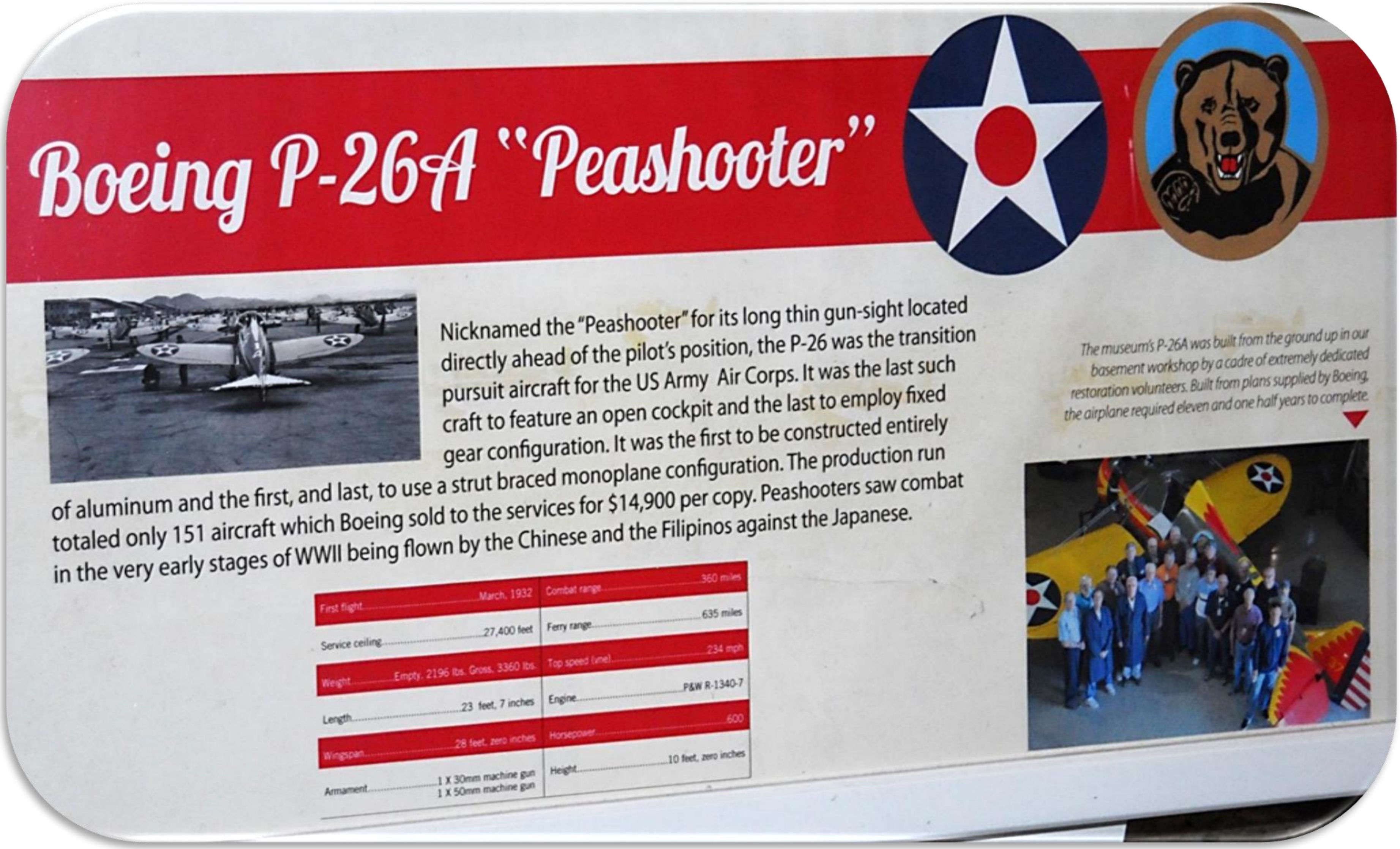

Boeing P-26A "Peashooter"

Nicknamed the "Peashooter" for its long thin gun-sight located directly ahead of the pilot's position, the P-26 was the transition pursuit aircraft for the US Army Air Corps. It was the last such craft to feature an open cockpit and the last to employ fixed gear configuration. It was the first to be constructed entirely of aluminum and the first, and last, to use a strut braced monoplane configuration. The production run totaled only 151 aircraft which Boeing sold to the services for $14,900 per copy. Peashooters saw combat in the very early stages of WWII being flown by the Chinese and the Filipinos against the Japanese.

First flight	March, 1932	Combat range	360 miles
Service ceiling	27,400 feet	Ferry range	635 miles
Weight	Empty, 2196 lbs. Gross, 3360 lbs.	Top speed (vne)	234 mph
Length	23 feet, 7 inches	Engine	P&W R-1340-7
Wingspan	28 feet, zero inches	Horsepower	600
Armament	1 X 30mm machine gun 1 X 50mm machine gun	Height	10 feet, zero inches

The museum's P-26A was built from the ground up in our basement workshop by a cadre of extremely dedicated restoration volunteers. Built from plans supplied by Boeing, the airplane required eleven and one half years to complete.

Extra Info: Nicknamed **"Peashooter"** for its long thin gun-sight located directly ahead of the pilot.

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World War II Gallery

1st flight: 1944
(3 known built)

Key Points:

Horten 229 V3 (Model) **1944,** WW II, U.S. discovered top-secret facility in Germany with an advanced, jet-powered aircraft; the first flying wing to be powered by jet engines The 229 was brought back to the United States to be studied. 2009, **National Geographic and Northrop Grumman** built full sized model for documentary *Hitler's Stealth Fighter,* **this is that model**. At a **Northrop Grumman test range in the Mojave Desert**, this model was mounted off the ground and WW II vintage radar was aimed at it from every angle. Radar detection technology revealed that the **Horten's Radar image was 60% less than the Messerschmitt Bf 109**. Experts speculate that the Horten could have been an effective weapon. The **Smithsonian has since posted an extensive debunking of the stealth claims**. The captured Horten 229 is at the Smithsonian for restoration.

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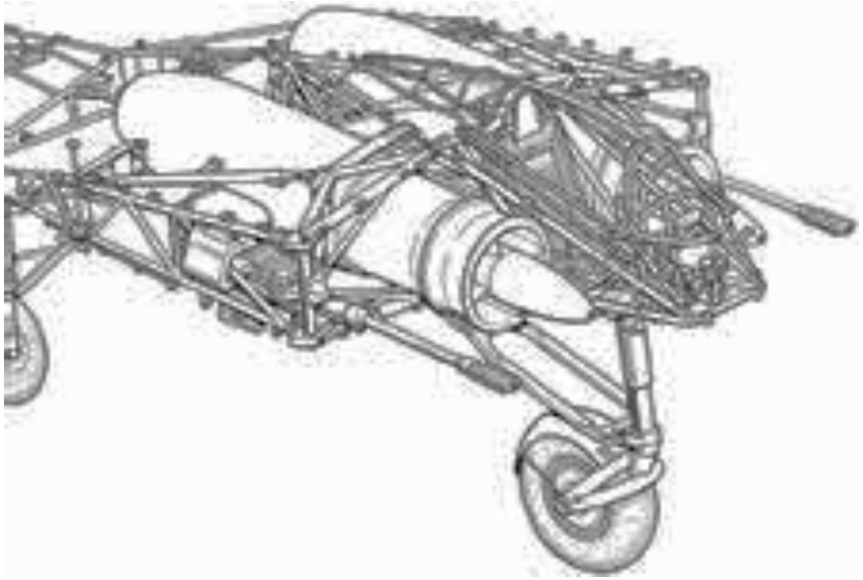

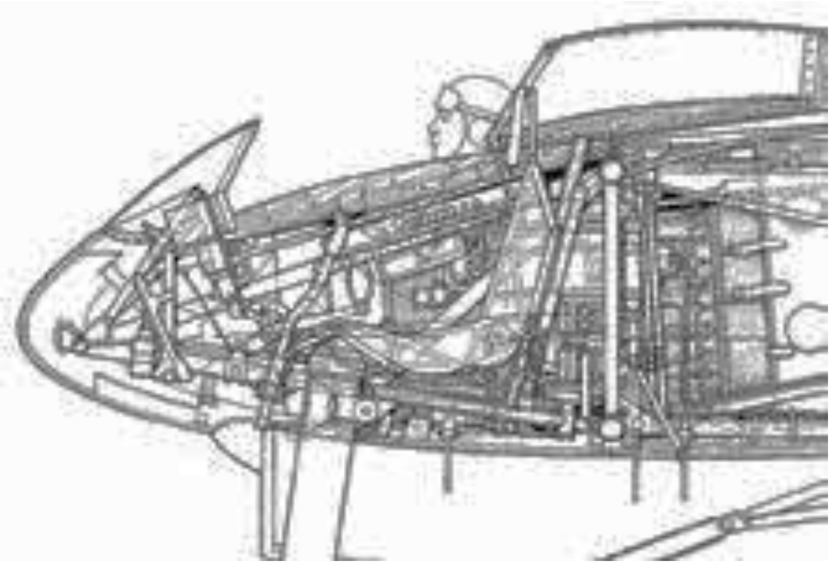

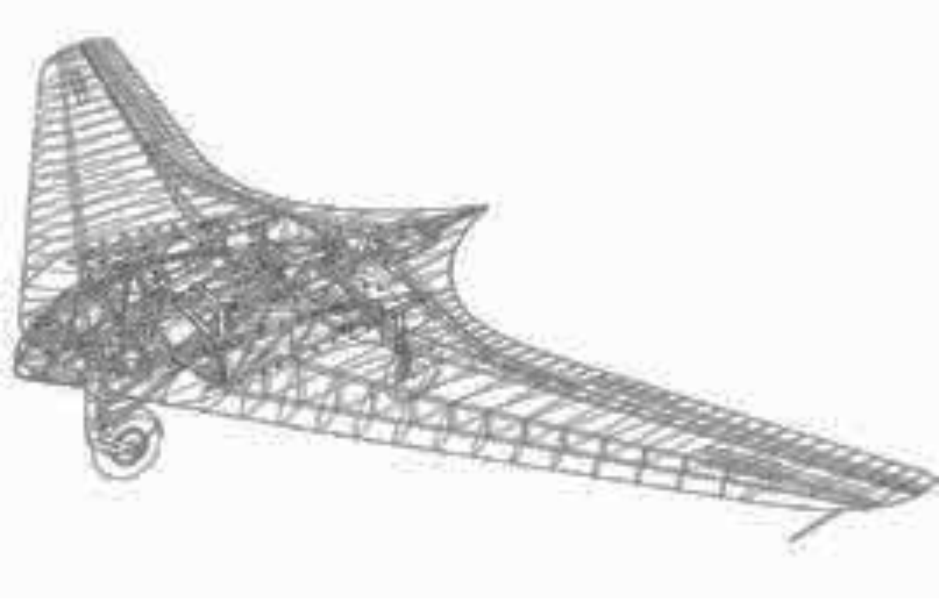

TECHNICAL DATA

MANUFACTURER:	Gothaer Waggonfabrik
POWERPLANT:	Junkers Jumbo 004 B
SPAN:	55 ft
LENGTH:	24 ft 6 in
HEIGHT:	9 ft 2 in
WEIGHT:	Empty 20,910 lbs (gross, 33,975 lbs)
MAX SPEED:	607 mph
YEAR BUILT:	Original, 1944; Model 2009

Jumo, not Jumbo

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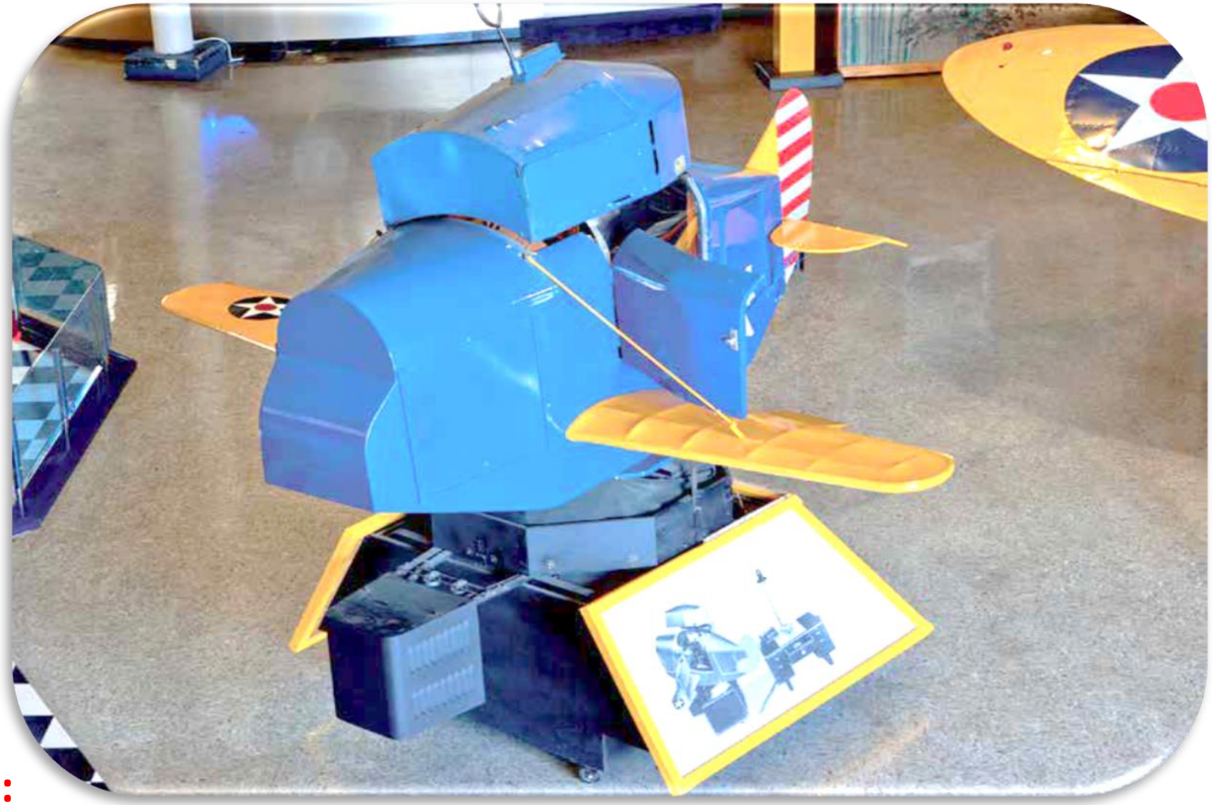

1st used: 1929
(10,000+ built)

Key Points:

Link Trainer (**Original**). Edwin Link's invention of a 'moving' basic flight trainer in **1929**, which could simulate the **roll, pitch and yaw** of a real airplane, was used initially in amusement parks. **1934**, the U. S. Army Air Corp contracted for first 6 Links, soon the capabilities of the "Pilot-Maker" became appreciated and the "Link" would be used in the training more than 500,000 pilots world wide, in instrument flying and radio procedures. Over 10,000 links built. Used by the U.S. military through 1972.

This: The type in use by the armed forces in the early 1940s.

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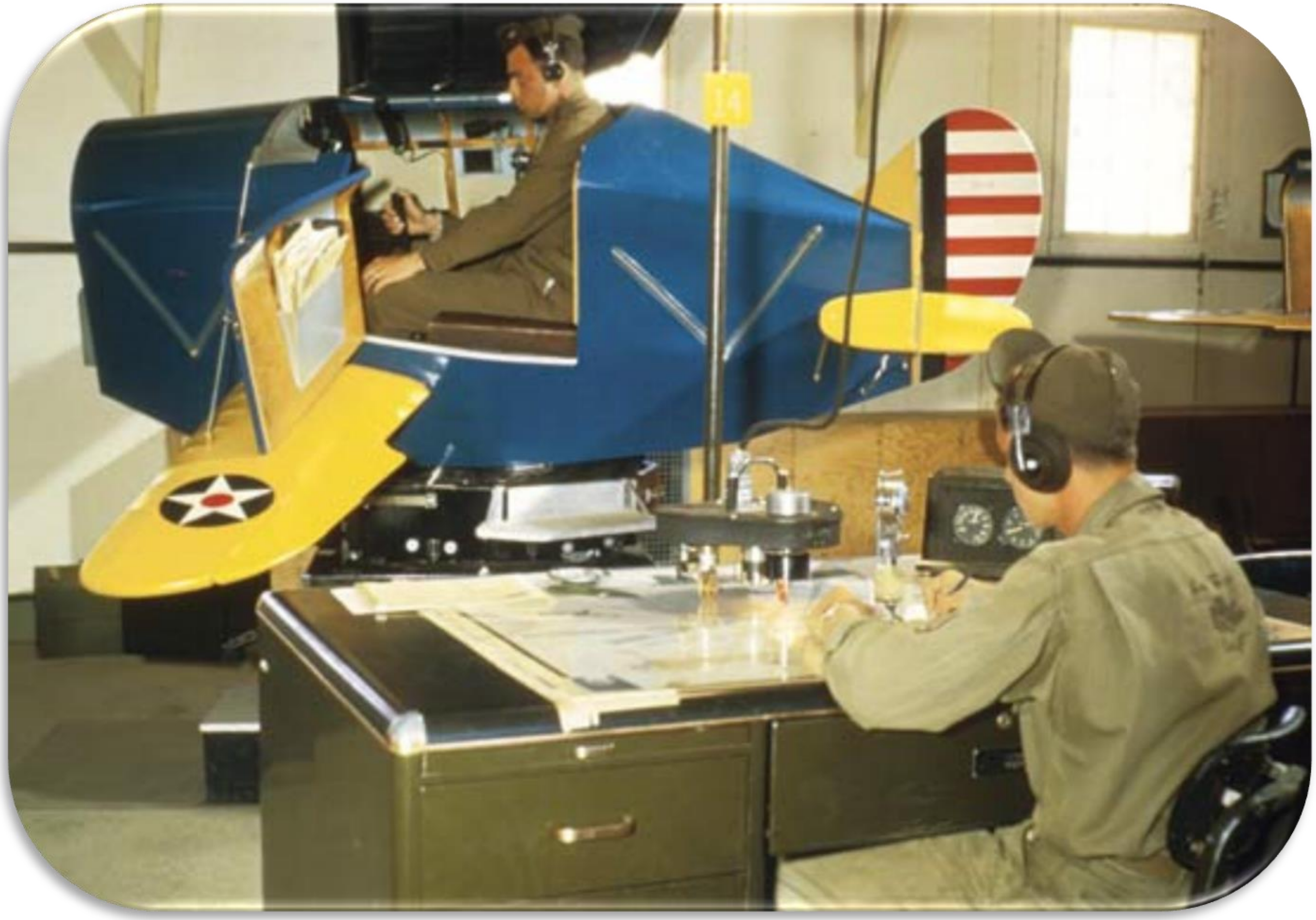
World War II Gallery



Once basic flying controls, navigation and radio procedures are mastered, the door and overhead hood are closed and instrument flying begins. The Link trainer operator at the desk can monitor ‘simulated’ location, heading, airspeed and altitude to track the student pilots progress.

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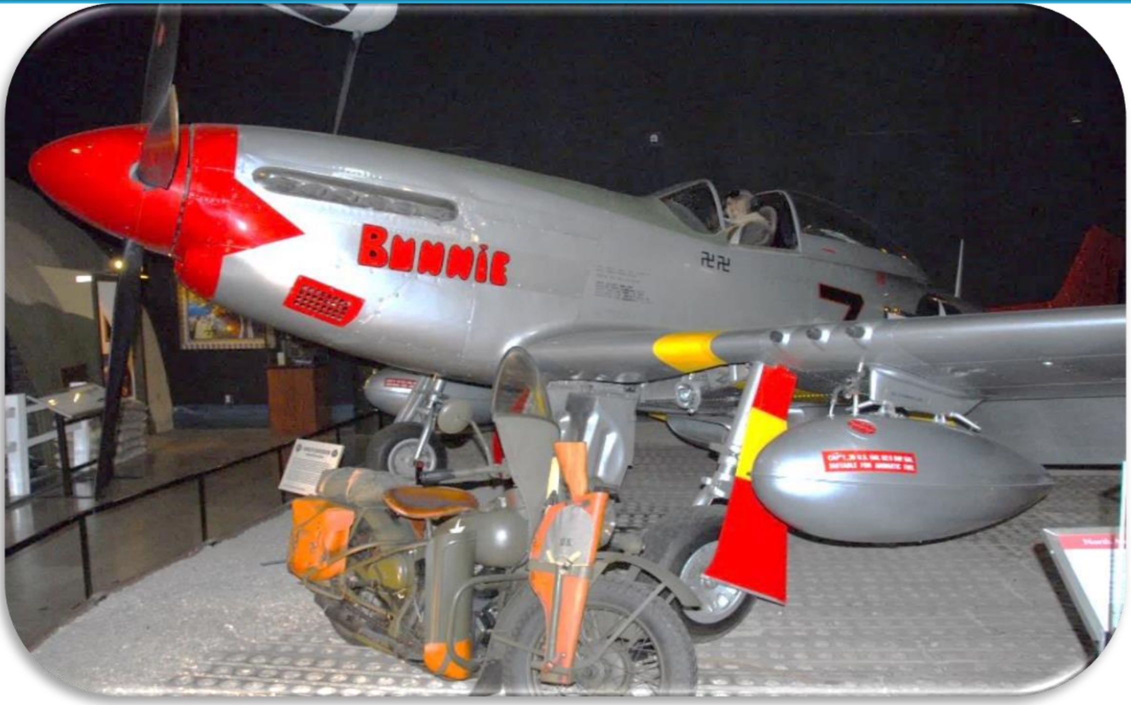

1st flight: 1940
(15,000+ built)

Key Points:

North American P-51D Mustang (Original). A "**fighter pilot's dream**." Perhaps "**Best known fighter aircraft of all time**". Designed by Edgar Schmued, (in record time), in **1940**, possessed a deadly combination of speed, endurance, maneuverability and firepower. **15,000+ P-51s have been built**, serviced as an **escort fighter, fighter/bomber, dive bomber, reconnaissance aircraft, and a race plane**. Six 50 cal machine guns, Merlin engine @1490 hp., speed 437 mph, ceiling 41,900 ft., **950 mi range**. **Long range allowed the P-51, with drop tanks, to escort bombers into the heart of Germany and back to England**. Retired from US service, 1957. Many still flying in private hands.

This: Built in **Mar 1945** (although shipped to Europe, it saw no service in combat), colors of Tuskegee Captain Roscoe Brown, Commander, 100th Fighter Squadron.

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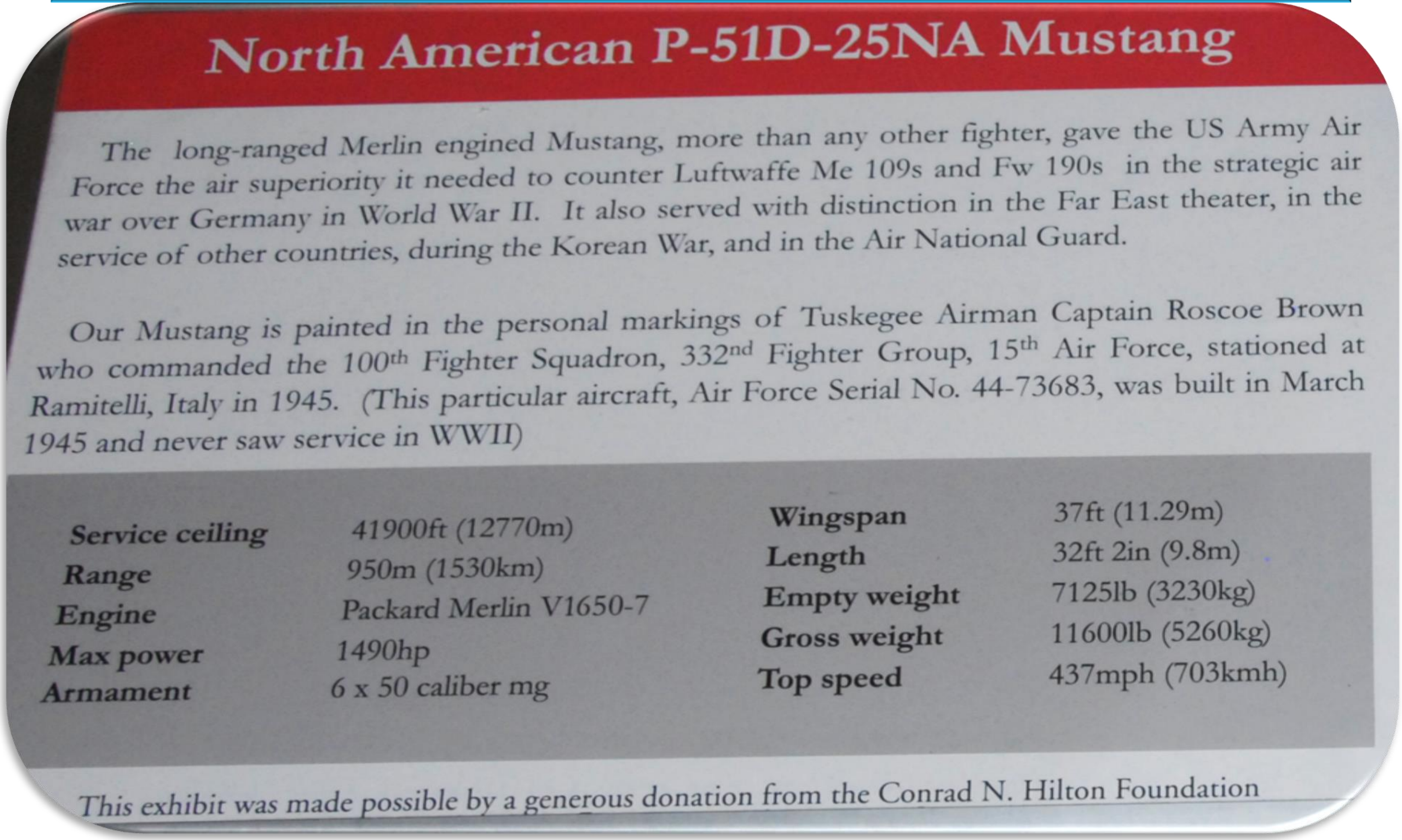

North American P-51D-25NA Mustang

The long-ranged Merlin engined Mustang, more than any other fighter, gave the US Army Air Force the air superiority it needed to counter Luftwaffe Me 109s and Fw 190s in the strategic air war over Germany in World War II. It also served with distinction in the Far East theater, in the service of other countries, during the Korean War, and in the Air National Guard.

Our Mustang is painted in the personal markings of Tuskegee Airman Captain Roscoe Brown who commanded the 100th Fighter Squadron, 332nd Fighter Group, 15th Air Force, stationed at Ramitelli, Italy in 1945. (This particular aircraft, Air Force Serial No. 44-73683, was built in March 1945 and never saw service in WWII)

Service ceiling	41900ft (12770m)	**Wingspan**	37ft (11.29m)
Range	950m (1530km)	**Length**	32ft 2in (9.8m)
Engine	Packard Merlin V1650-7	**Empty weight**	7125lb (3230kg)
Max power	1490hp	**Gross weight**	11600lb (5260kg)
Armament	6 x 50 caliber mg	**Top speed**	437mph (703kmh)

This exhibit was made possible by a generous donation from the Conrad N. Hilton Foundation

The starboard side of the vertical fin is signed by **Captain Roscoe Brown**, Commander, 100th Fighter Squadron.

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Claire Chennault's FLYING TIGERS
In China
1941 - 1942

1941 – 1942

Key Points:

The **1st American Volunteer Group** (**AVG**) of the **Chinese Air Force** in **1941–1942**, nicknamed ***Flying Tigers***, composed of **100 pilots** from Army, Navy, and Marines and **100 P-40 aircraft**. Recruited under presidential authority (Roosevelt), and commanded by **Claire Lee Chennault**, to fight for China against Japan. The **shark-faced nose art** remains among the most recognizable image of any individual combat aircraft or unit of WW II. **First combat on 20 December 1941**. **In 7 months, AVG pilots destroyed 296 enemy aircraft, while losing only 14 pilots in combat**. Announcements of their **innovative tactical victories,** when news in the U.S. was filled with defeats by Japanese forces, was a **National moral boost**. On 4 July 1942 the AVG was disbanded.

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1941 China Mural
Jon Petrie
AVG P-40's
來華助戰
洋人(美國)
軍民一體
救護

The Flying Tigers were based primarily out of **Rangoon, Burma, and Kunming**.

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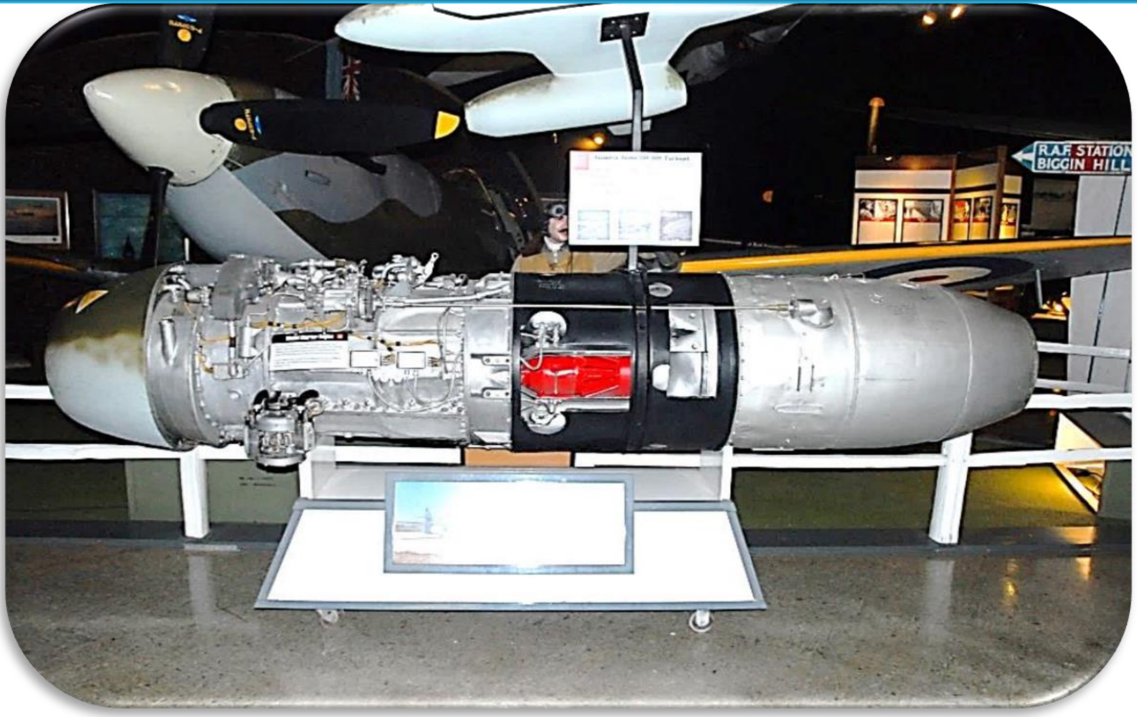

1st flight: 1942
(8,000+ built)

Key Points:

Junkers Jumo 004. (Original). World's **1st production turbojet engine and 1st successful axial compressor jet engine ever built**. Used for the **Messerschmitt Me 262** fighter jet, Arado Ar 234 jet and the **Horten Ho 229**. Starter system was a 10 hp 2- stroke flat engine functioning as an Auxiliary Power Unit. **Vibration problems** with compressor stators; replaced aluminum stators with steel. **Jul 18, 1942**, Me 262 1st flew under jet power from its 004 engines. 1943, engine again suffered **turbine blade failures**. Modified the blades and reduced engine rpm from 9,000 to 8,700. **Poor alloy steel** caused **service life as low as 10–25 hours**. Engine drawbacks were sluggish throttle response (turbo lag), and injecting too much fuel allowing heat to build up. Heat softened the turbine blades, which along with harmonic vibrations, were major causes for engine failures. **Time between major overhauls was 30 to 50 hours.**

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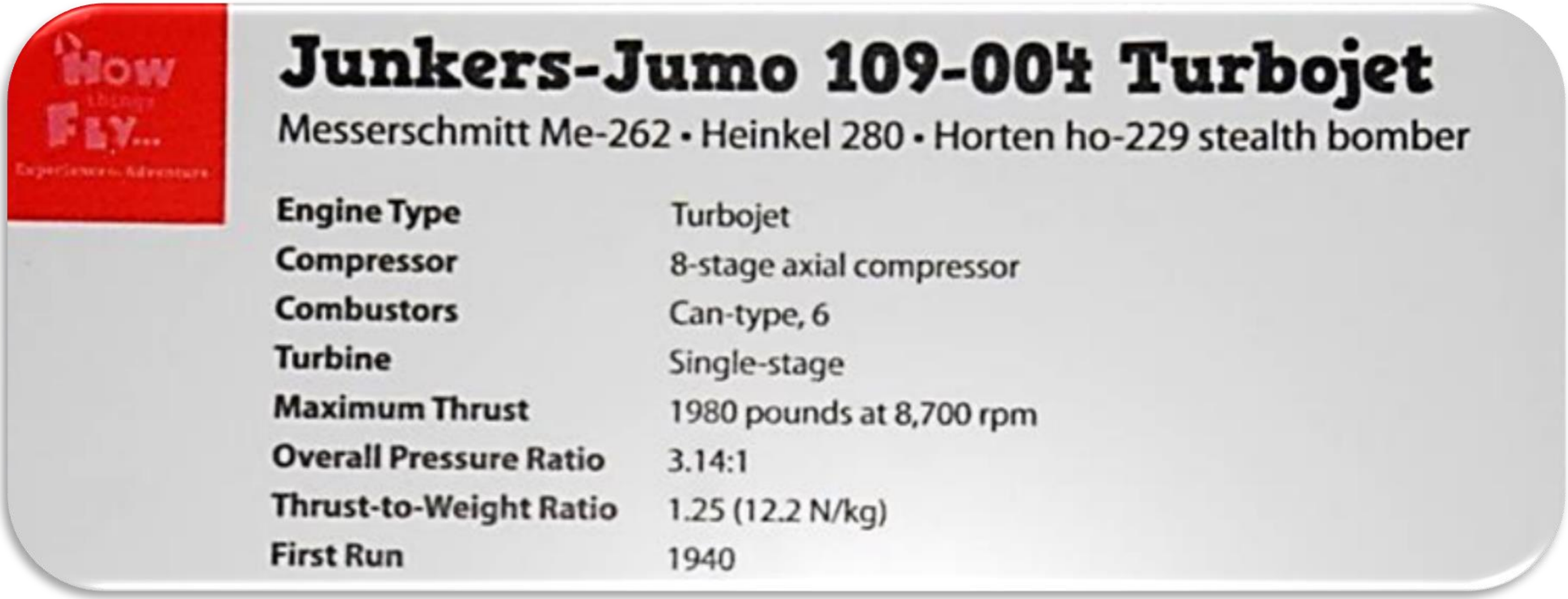


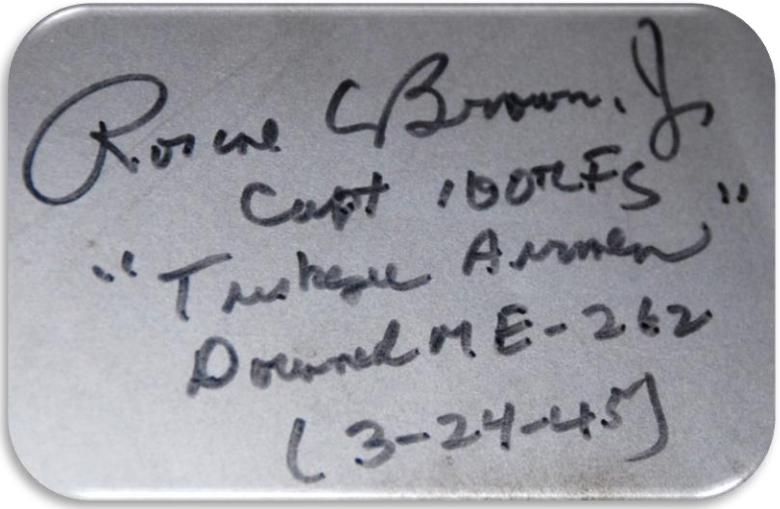
Junkers-Jumo 109-004 Turbojet

Messerschmitt Me-262 • Heinkel 280 • Horten ho-229 stealth bomber

Engine Type	Turbojet
Compressor	8-stage axial compressor
Combustors	Can-type, 6
Turbine	Single-stage
Maximum Thrust	1980 pounds at 8,700 rpm
Overall Pressure Ratio	3.14:1
Thrust-to-Weight Ratio	1.25 (12.2 N/kg)
First Run	1940

Extra Info:

Engine signed by Capt. Roscoe C. Brown Jr. (March 9, 1922 – July 2, 2016), a Tuskegee Airmen and a **Squadron Commander** of the 100th Fighter Squadron of the 332nd Fighter Group during WWII.



Roscoe C Brown, Jr.
Capt 100thFS
"Tuskegee Airmen"
Downed ME-262
(3-24-45)

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1st flight: 1942

(1443 built)

Key Points:

Messerschmitt Me 262 *Schwalbe* (Eng: "Swallow") (Model) First flight: **18 July 1942**. **World's first operational jet powered fighter**. **1443 Me 262's produced**. Designed before WW II, engine problems & politics kept from operational status until mid-1944. **Heavily armed** (4 ea 30mm cannon)**, faster** (540 mph) **than any Allied fighter**, flight endurance: 60 to 90 minutes. One of the most advanced aviation designs in operational use during WW II. Pilots claimed **over 542 Allied kills**. Allies countered by **attacking the aircraft on the ground and during takeoff and landing**. **Engine reliability problems** reduced the effectiveness of the aircraft. Captured Me 262s were studied and tested by major powers and **influenced the designs of the North American F-86 Sabre and Boeing B-47 Stratojet**.

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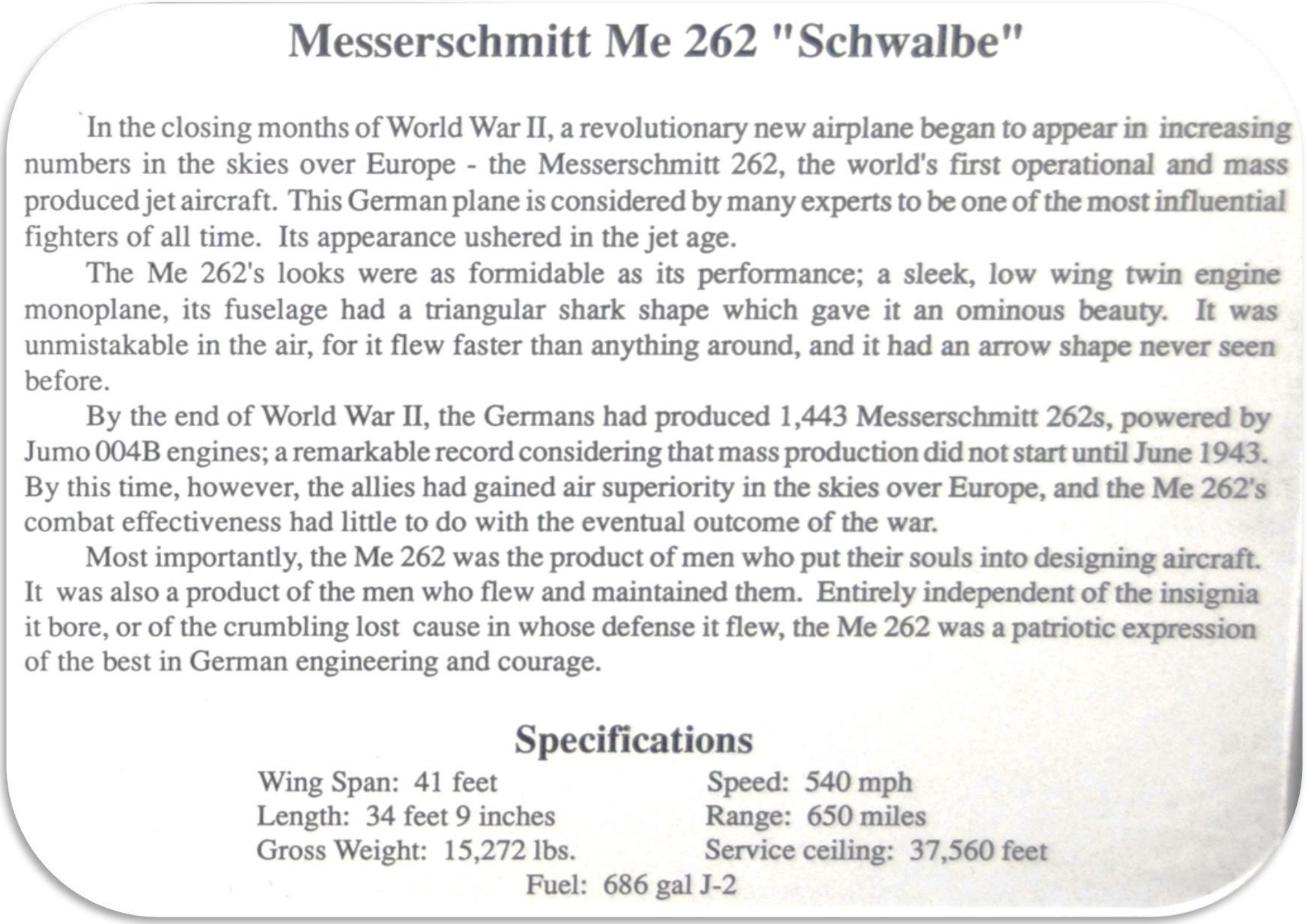

Messerschmitt Me 262 "Schwalbe"

In the closing months of World War II, a revolutionary new airplane began to appear in increasing numbers in the skies over Europe - the Messerschmitt 262, the world's first operational and mass produced jet aircraft. This German plane is considered by many experts to be one of the most influential fighters of all time. Its appearance ushered in the jet age.

The Me 262's looks were as formidable as its performance; a sleek, low wing twin engine monoplane, its fuselage had a triangular shark shape which gave it an ominous beauty. It was unmistakable in the air, for it flew faster than anything around, and it had an arrow shape never seen before.

By the end of World War II, the Germans had produced 1,443 Messerschmitt 262s, powered by Jumo 004B engines; a remarkable record considering that mass production did not start until June 1943. By this time, however, the allies had gained air superiority in the skies over Europe, and the Me 262's combat effectiveness had little to do with the eventual outcome of the war.

Most importantly, the Me 262 was the product of men who put their souls into designing aircraft. It was also a product of the men who flew and maintained them. Entirely independent of the insignia it bore, or of the crumbling lost cause in whose defense it flew, the Me 262 was a patriotic expression of the best in German engineering and courage.

Specifications

Wing Span: 41 feet
Length: 34 feet 9 inches
Gross Weight: 15,272 lbs.
Speed: 540 mph
Range: 650 miles
Service ceiling: 37,560 feet
Fuel: 686 gal J-2

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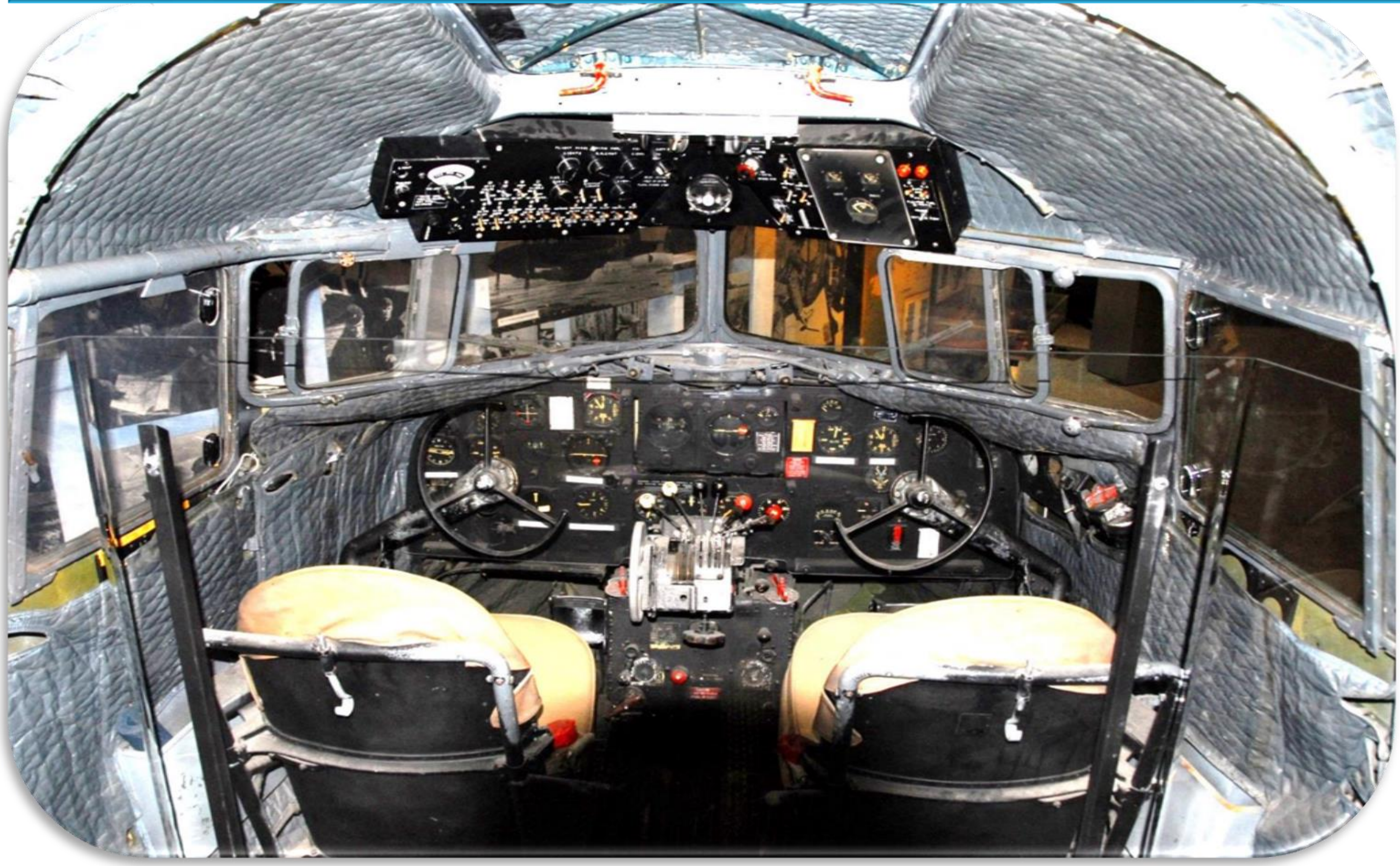

1^{st} flight:
1941
(10,000+ built)

Key Points: **Douglas C-47 (DC-3) Cockpit** (**Original**). Douglas DC series began in **1936** with a pair of DC-2's. **1941**, the **DC-3**, (**C-47** Skytrain), became the **standard US transport aircraft**. The C-47 could carry **6,000 pounds** of cargo, or a fully assembled **jeep** or a **37 mm cannon**.

This: The Museum's C-47 nose and cockpit section are on loan from the Smithsonian National Air & Space Museum. It was placed on display in 1992.

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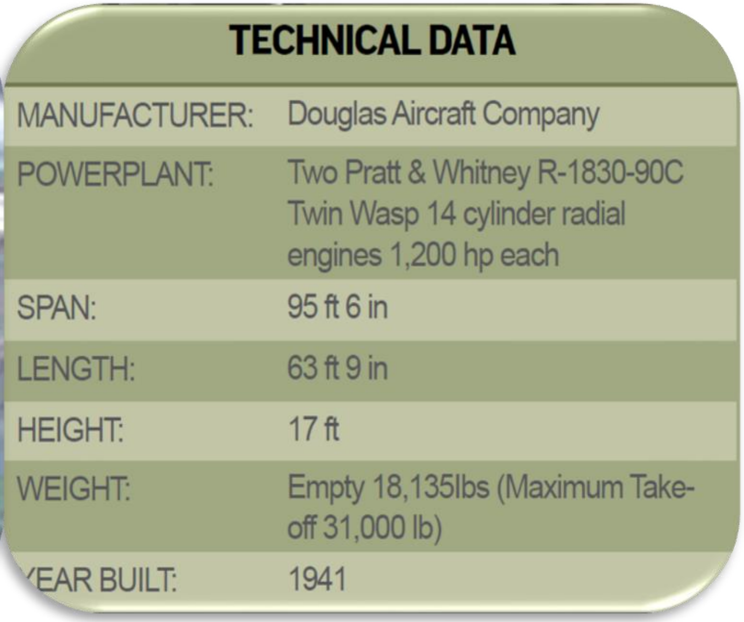


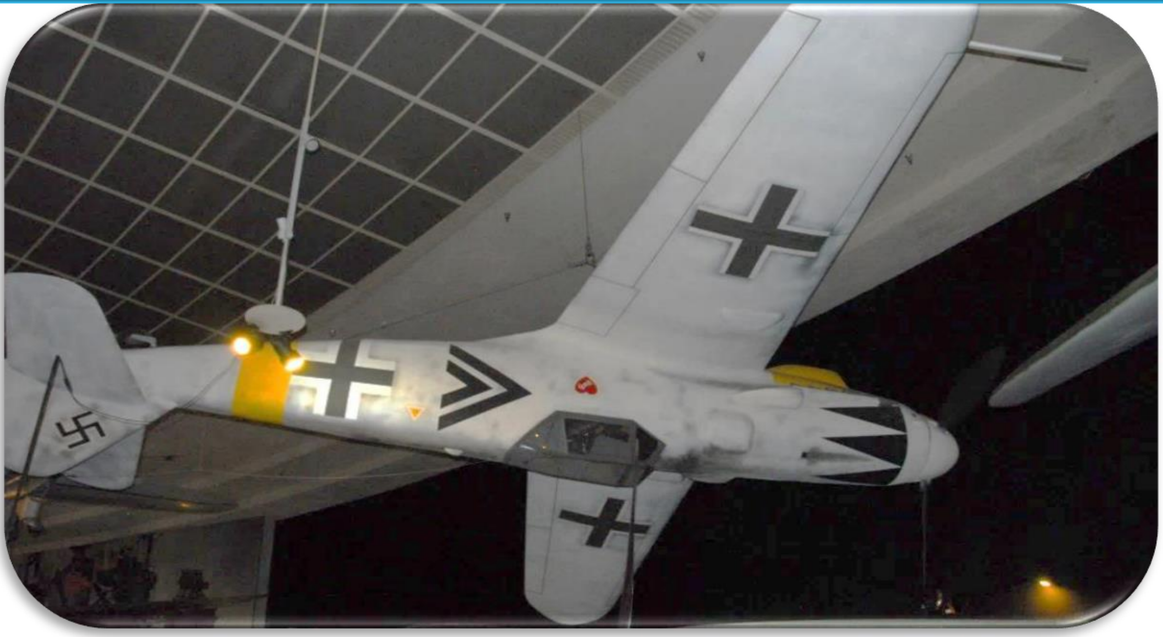
TECHNICAL DATA

MANUFACTURER:	Douglas Aircraft Company
POWERPLANT:	Two Pratt & Whitney R-1830-90C Twin Wasp 14 cylinder radial engines 1,200 hp each
SPAN:	95 ft 6 in
LENGTH:	63 ft 9 in
HEIGHT:	17 ft
WEIGHT:	Empty 18,135lbs (Maximum Take-off 31,000 lb)
YEAR BUILT:	1941

Extra Info: As a transport, the **Douglas C-47** carried **28 soldiers** in full combat gear or it could accommodate **14 stretcher patients** & 3 nurses. More than **10,000** have been built.

For all of its official and unofficial names, C-47s came to be known universally as the **"gooney Bird."** General Dwight D. Eisenhower, Supreme Commander of Allied Forces in Europe, termed it one of the most vital pieces of military equipment used in winning the war. C-47's remained in active military service long after the end of World War II. They played a critical role in the 1948 Berlin Airlift and saw action in the Korean and Vietnam wars.

World War II Gallery



1st flight: 1935
(35,000+ built)

Key Points:

Messerschmitt Bf 109G-14 (Model). **Most famous German fighter**, some still flying 1967. **Estimated 35,000 were built**. Willy Messerschmitt designed, in late **1933**, from civil sport plane, Bf 108 Taifun. All-metal stressed-skin. **Production started in 1937**. Most technically advanced fighter in the world. Set a world speed record. 1st combat in 1937, Spanish Civil War. In WW II, Bf 109E & Spitfire were adversaries during Battle of Britain. **109E heavier armament, a fuel injected engine, and a higher rate of climb**. The 109 had "heavy“ high speed (>250kts) control forces which limited rapid maneuvers and increased high speed stalls. Limited fuel (20 min over England) and range limited effectiveness. **Bf 109F & 109G, most produced fighters in the world**, over 33,000 built.

This: Full-scale model by **George N. Lucas**, August **1978**. Bf 109 is painted in the winter colors of the worlds all time highest scoring Ace, **Erich Hartmann.**

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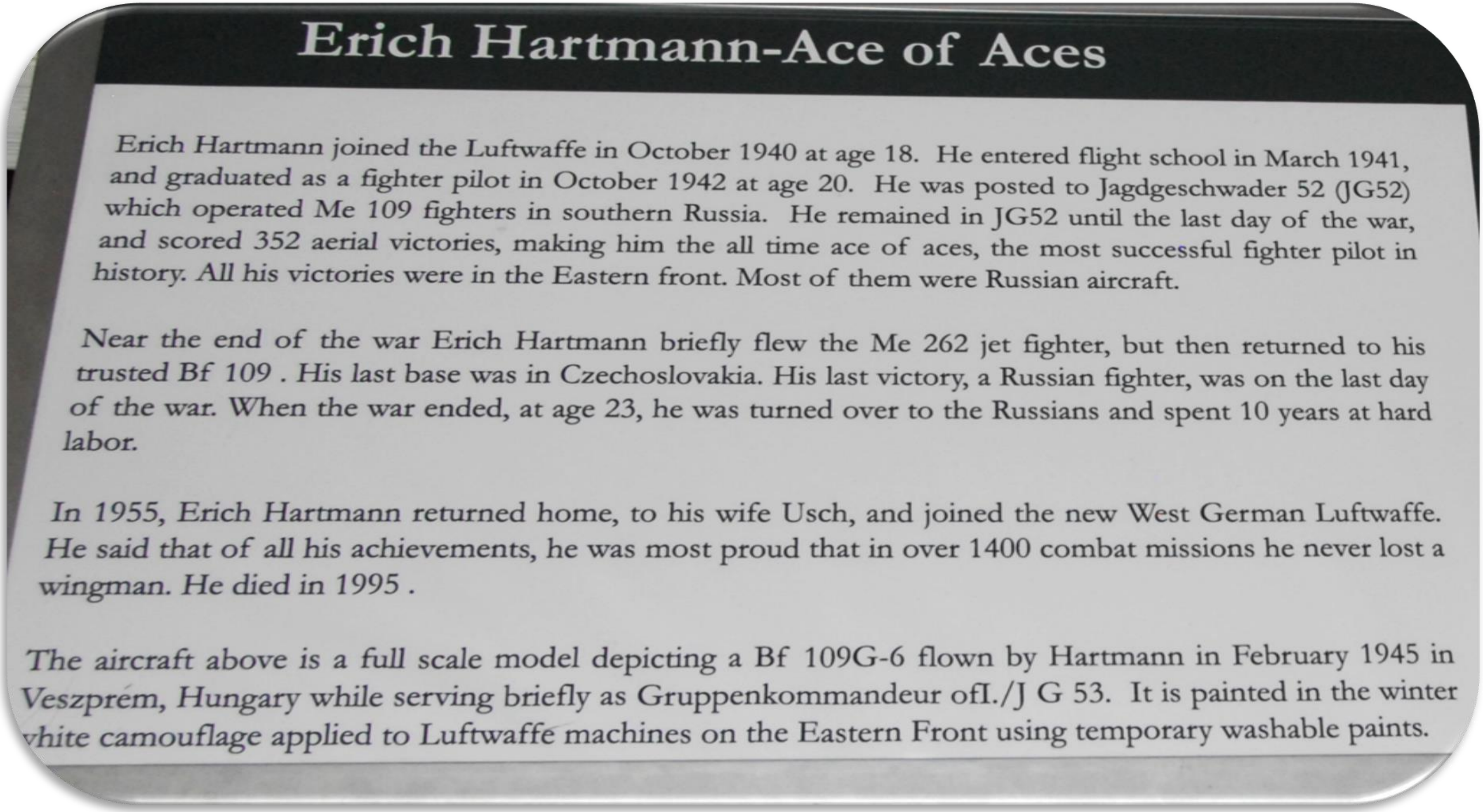

Erich Hartmann-Ace of Aces

Erich Hartmann joined the Luftwaffe in October 1940 at age 18. He entered flight school in March 1941, and graduated as a fighter pilot in October 1942 at age 20. He was posted to Jagdgeschwader 52 (JG52) which operated Me 109 fighters in southern Russia. He remained in JG52 until the last day of the war, and scored 352 aerial victories, making him the all time ace of aces, the most successful fighter pilot in history. All his victories were in the Eastern front. Most of them were Russian aircraft.

Near the end of the war Erich Hartmann briefly flew the Me 262 jet fighter, but then returned to his trusted Bf 109 . His last base was in Czechoslovakia. His last victory, a Russian fighter, was on the last day of the war. When the war ended, at age 23, he was turned over to the Russians and spent 10 years at hard labor.

In 1955, Erich Hartmann returned home, to his wife Usch, and joined the new West German Luftwaffe. He said that of all his achievements, he was most proud that in over 1400 combat missions he never lost a wingman. He died in 1995 .

The aircraft above is a full scale model depicting a Bf 109G-6 flown by Hartmann in February 1945 in Veszprém, Hungary while serving briefly as Gruppenkommandeur ofI./J G 53. It is painted in the winter white camouflage applied to Luftwaffe machines on the Eastern Front using temporary washable paints.

Key Points:

Erich Hartmann – highest scoring Ace in world history with 352 aerial victories in over 1400 missions. Lived to be 73 years old.

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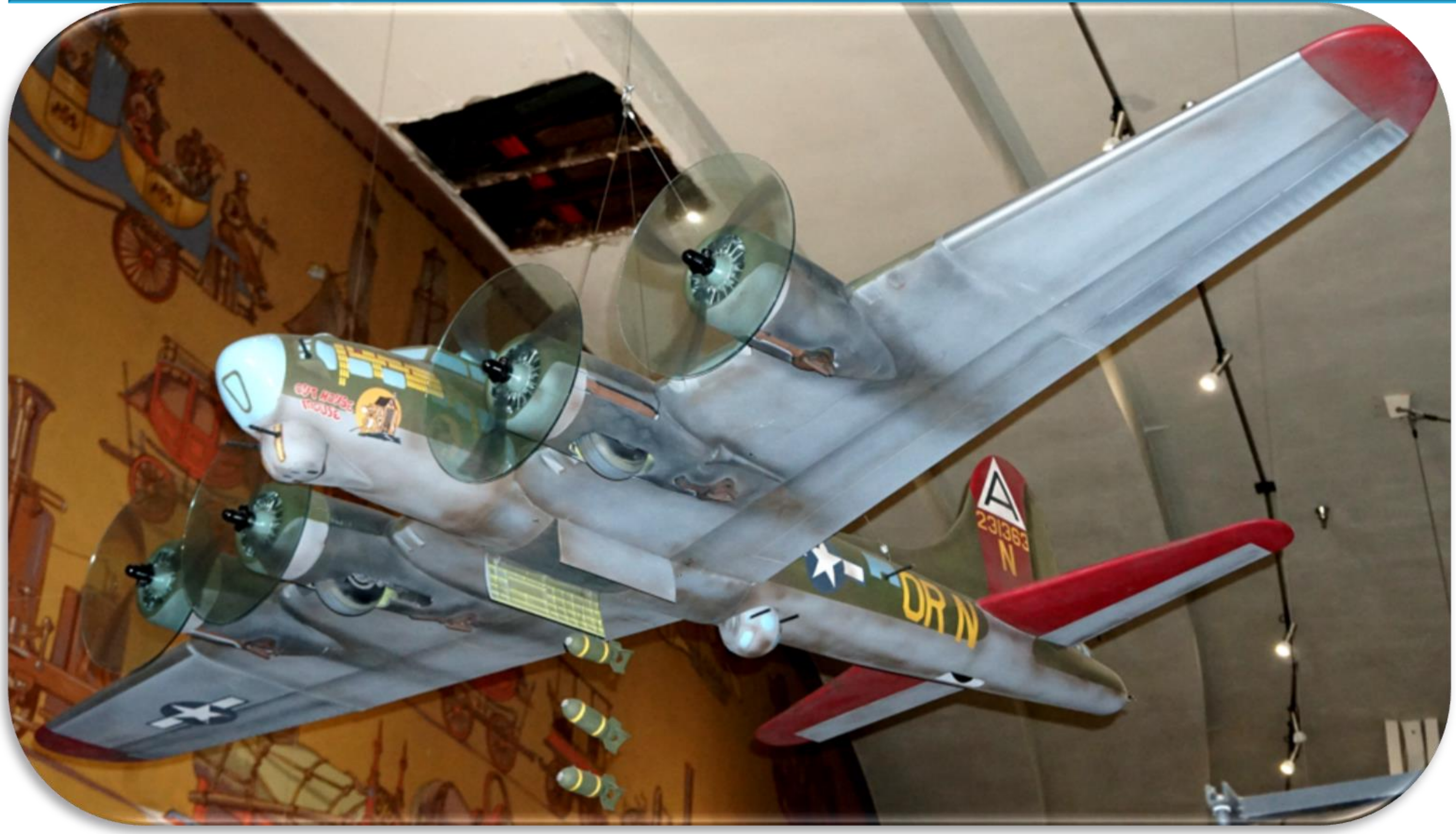

B-17
1^{st} flight:
1935
(12,731 built)

Key Points: **Boeing B-17 Flying Fortress** (Model) a four-engine **heavy bomber** developed in the 1930s for the U. S. From its introduction in 1938, the B-17 Flying Fortress evolved through numerous design advances, becoming the **third-most produced bomber of all time**, behind the four-engine **Consolidated B-24** Liberator and the multirole, twin-engine **Junkers Ju 88**. The **B-17 dropped more bombs than any other U.S. aircraft in World War II.**

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Extra Info: B-17 primarily employed by US in **daylight strategic bombing** of German industrial and military targets. US **Eighth Air Force**, based across England, and the Fifteenth Air Force, based in Italy, **complemented the RAF Bomber Command's night-time area bombing** to help secure air superiority over Western Europe in preparation for the **D-Day invasion** of France in 1944. The B-17 also participated to a lesser extent in the **War in the Pacific**, early in World War II, where it conducted raids **against Japanese shipping and airfields**.

The B-17, as a strategic weapon, was **relatively fast, high-flying, long-range bomber** with **heavy defensive armament** at the expense of bombload. It developed a **reputation for toughness** based upon the number of badly damaged B-17s safely returning to base.

Of approximately 1.5 million tons of bombs dropped during WWII by U.S. aircraft, **over 640,000 tons were dropped from B-17s**. The B-17 was also employed as a **transport, antisubmarine aircraft, drone controller, and search-and-rescue aircraft.**

General Specifications	B-17	B-24
Crew:	10	11
Length:	74 ft 4 in	67 ft 2 in
Wingspan:	103 ft 9 in	110 ft
Gross weight:	54,000 lb	55,000 lb
Powerplant:	4 × Wright R-1820 @1,200 hp	4 × P & W R-1830 @1,200 hp
Performance		
Maximum speed:	287 mph	297 mph
Cruise speed:	182 mph	215 mph
Range:	2,000 mi	2,100 mi
Service ceiling:	35,600 ft	28,000 ft
Armament		
Guns:	13 × .50 caliber	10 × .50 caliber
Bombs, Short Flt:	8,000 lb	8,000 lb
Bombs, Long Flt:	4,500 lb	5,000 lb

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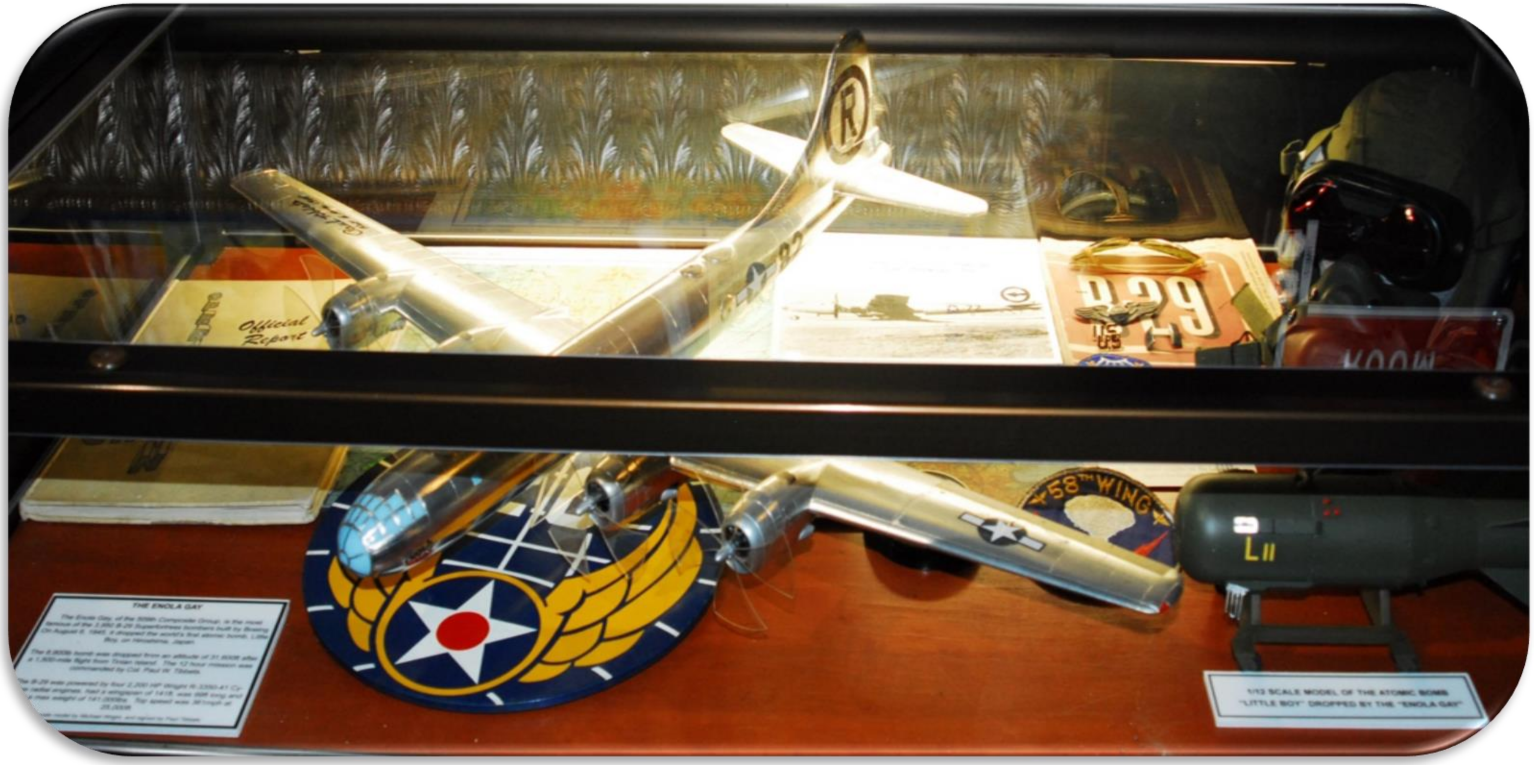

B-29
1st flight:
1942
(3970 built)

Key Points: ***Enola Gay* -** Boeing's B-29 Superfortress, most sophisticated propeller-driven bomber of WW II, and the first bomber with **pressurized compartments**.
On **August 6, 1945**, the ***Enola Gay*** dropped the **first atomic weapon** (*little Boy*) used in combat on **Hiroshima**, Japan. Three days later, B-29, *Bockscar*, dropped a second atomic bomb (*Fat Man*) on Nagasaki, Japan.
This: Model signed by BG Paul Tibbets, Aircraft Commander and pilot of the Enola Gay during the Aug 6, 1945, Hiroshima bombing.

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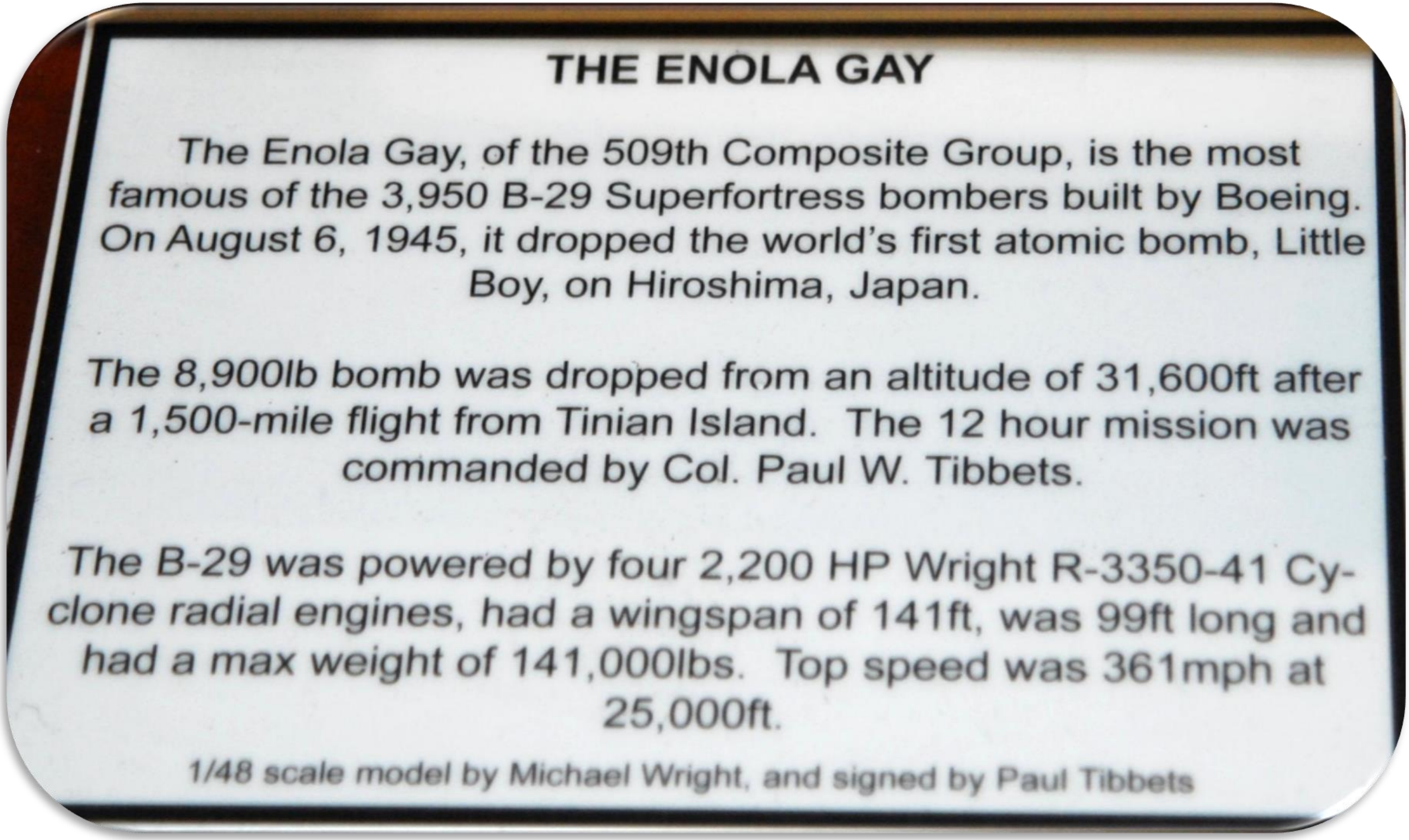

THE ENOLA GAY

The Enola Gay, of the 509th Composite Group, is the most famous of the 3,950 B-29 Superfortress bombers built by Boeing. On August 6, 1945, it dropped the world's first atomic bomb, Little Boy, on Hiroshima, Japan.

The 8,900lb bomb was dropped from an altitude of 31,600ft after a 1,500-mile flight from Tinian Island. The 12 hour mission was commanded by Col. Paul W. Tibbets.

The B-29 was powered by four 2,200 HP Wright R-3350-41 Cyclone radial engines, had a wingspan of 141ft, was 99ft long and had a max weight of 141,000lbs. Top speed was 361mph at 25,000ft.

1/48 scale model by Michael Wright, and signed by Paul Tibbets

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1st flight: 1937
(22,000 built)

Key Points:

Supermarine Spitfire Mk.XVI (Original). Spitfire & Hawker Hurricane are the best known British aircraft. **Key in the 1940 Battle of Britain**. Designed from Schneider Trophy racing Seaplanes, a collaboration with Rolls-Royce and designer, Reginald Mitchell. A merger of all technical knowledge of the time into one airplane. **1st flew Mar, 1937. Production** began **Aug, 1938; more than 22,000 Spitfires built of 52 different variants, production ended in 1946**. **Faster than the Bf 109E, but inferior in rate of climb, armament, and fuel injection (no inverted flight or negative Gs).** By Jul & Aug 1940, many improvements to spitfire to match or exceed Bf 109 and Focke-Wulf 190. Spitfire **increased speed to 454 mph and ceiling to 43,000 ft with addition of turbocharger**.

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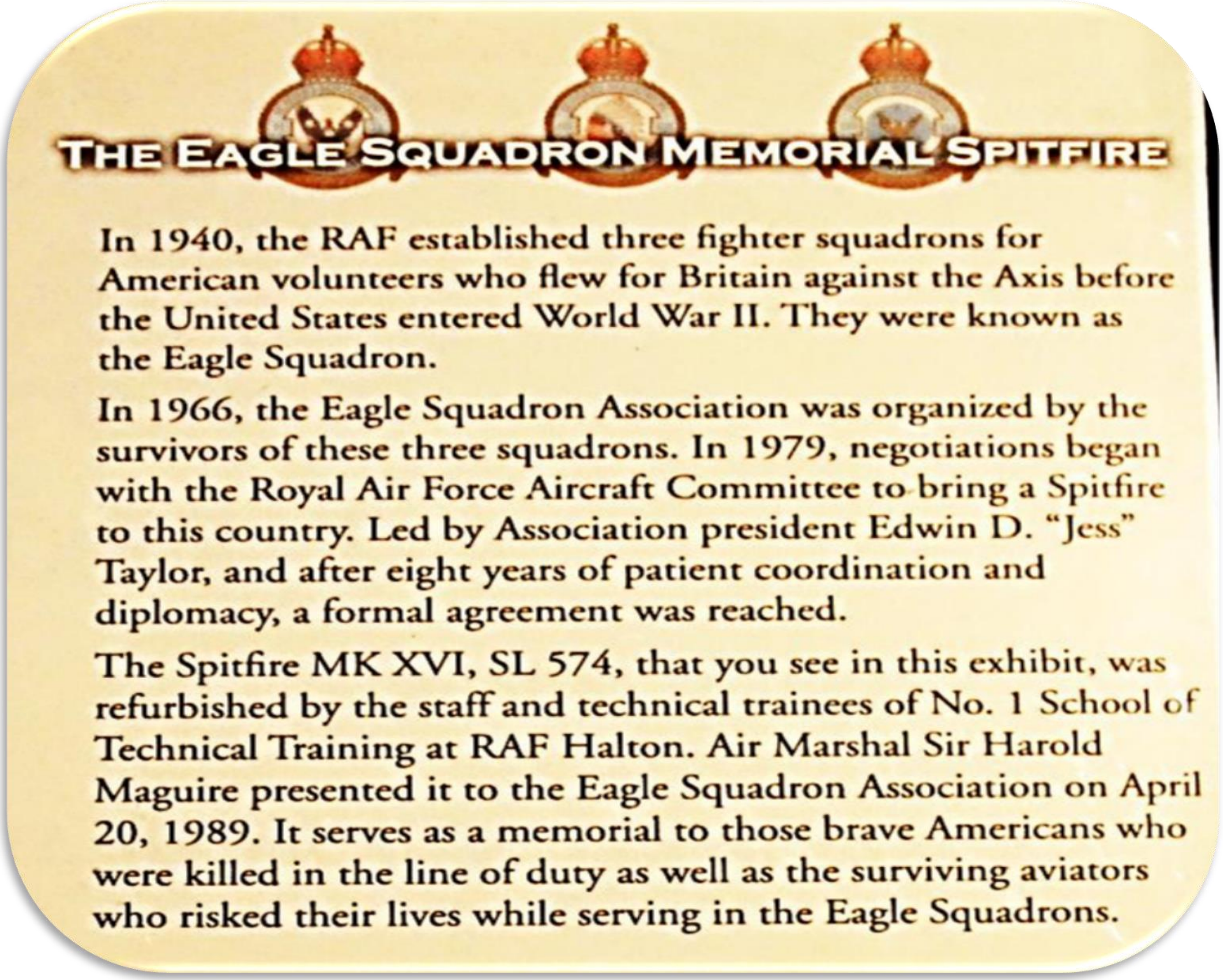

THE EAGLE SQUADRON MEMORIAL SPITFIRE

In 1940, the RAF established three fighter squadrons for American volunteers who flew for Britain against the Axis before the United States entered World War II. They were known as the Eagle Squadron.

In 1966, the Eagle Squadron Association was organized by the survivors of these three squadrons. In 1979, negotiations began with the Royal Air Force Aircraft Committee to bring a Spitfire to this country. Led by Association president Edwin D. "Jess" Taylor, and after eight years of patient coordination and diplomacy, a formal agreement was reached.

The Spitfire MK XVI, SL 574, that you see in this exhibit, was refurbished by the staff and technical trainees of No. 1 School of Technical Training at RAF Halton. Air Marshal Sir Harold Maguire presented it to the Eagle Squadron Association on April 20, 1989. It serves as a memorial to those brave Americans who were killed in the line of duty as well as the surviving aviators who risked their lives while serving in the Eagle Squadrons.

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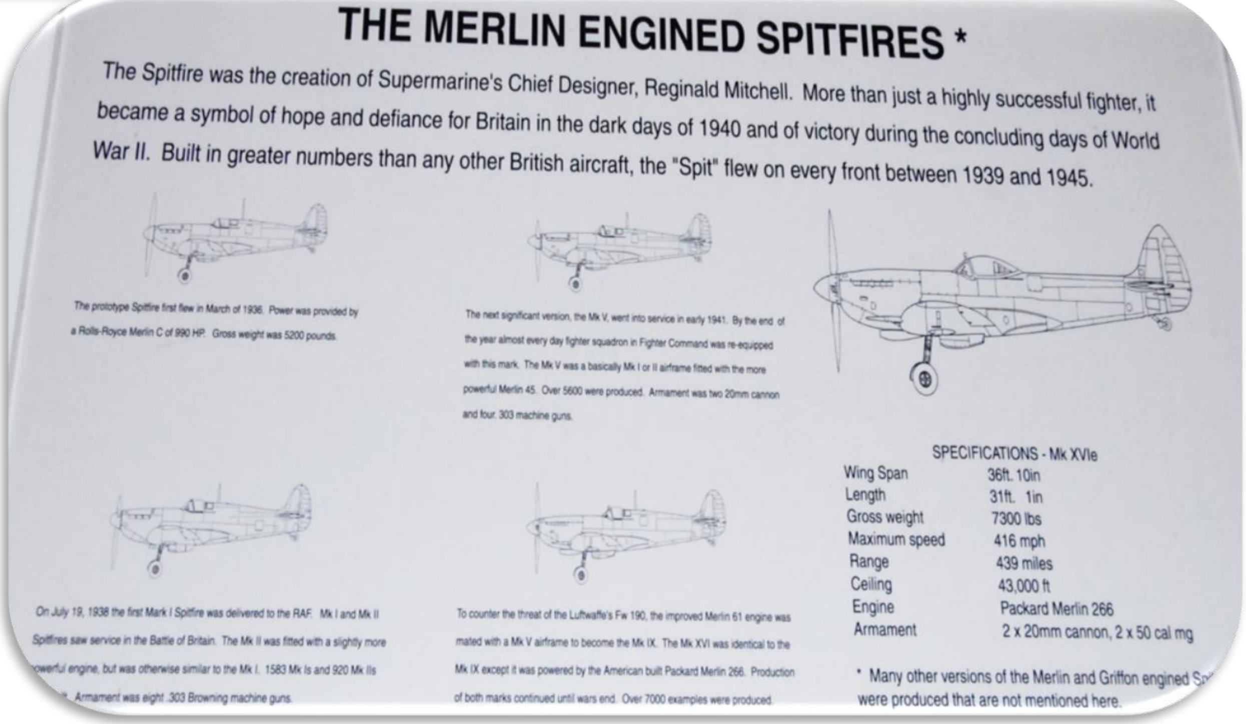
This: **A**cquisition of the Museum's Spitfire in April 1989, was due principally to the efforts of the Eagle Squadrons Association – those American pilots who flew for England before America entered WWII – and it is displayed in their honor.



THE MERLIN ENGINED SPITFIRES *

The Spitfire was the creation of Supermarine's Chief Designer, Reginald Mitchell. More than just a highly successful fighter, it became a symbol of hope and defiance for Britain in the dark days of 1940 and of victory during the concluding days of World War II. Built in greater numbers than any other British aircraft, the "Spit" flew on every front between 1939 and 1945.

The prototype Spitfire first flew in March of 1936. Power was provided by a Rolls-Royce Merlin C of 990 HP. Gross weight was 5200 pounds.

The next significant version, the Mk V, went into service in early 1941. By the end of the year almost every day fighter squadron in Fighter Command was re-equipped with this mark. The Mk V was a basically Mk I or II airframe fitted with the more powerful Merlin 45. Over 5600 were produced. Armament was two 20mm cannon and four .303 machine guns.

On July 19, 1938 the first Mark I Spitfire was delivered to the RAF. Mk I and Mk II Spitfires saw service in the Battle of Britain. The Mk II was fitted with a slightly more owerful engine, but was otherwise similar to the Mk I. 1583 Mk Is and 920 Mk IIs Armament was eight .303 Browning machine guns.

To counter the threat of the Luftwaffe's Fw 190, the improved Merlin 61 engine was mated with a Mk V airframe to become the Mk IX. The Mk XVI was identical to the Mk IX except it was powered by the American built Packard Merlin 266. Production of both marks continued until wars end. Over 7000 examples were produced.

SPECIFICATIONS - Mk XVIe

Wing Span	36ft. 10in
Length	31ft. 1in
Gross weight	7300 lbs
Maximum speed	416 mph
Range	439 miles
Ceiling	43,000 ft
Engine	Packard Merlin 266
Armament	2 x 20mm cannon, 2 x 50 cal mg

* Many other versions of the Merlin and Griffon engined Sp were produced that are not mentioned here.

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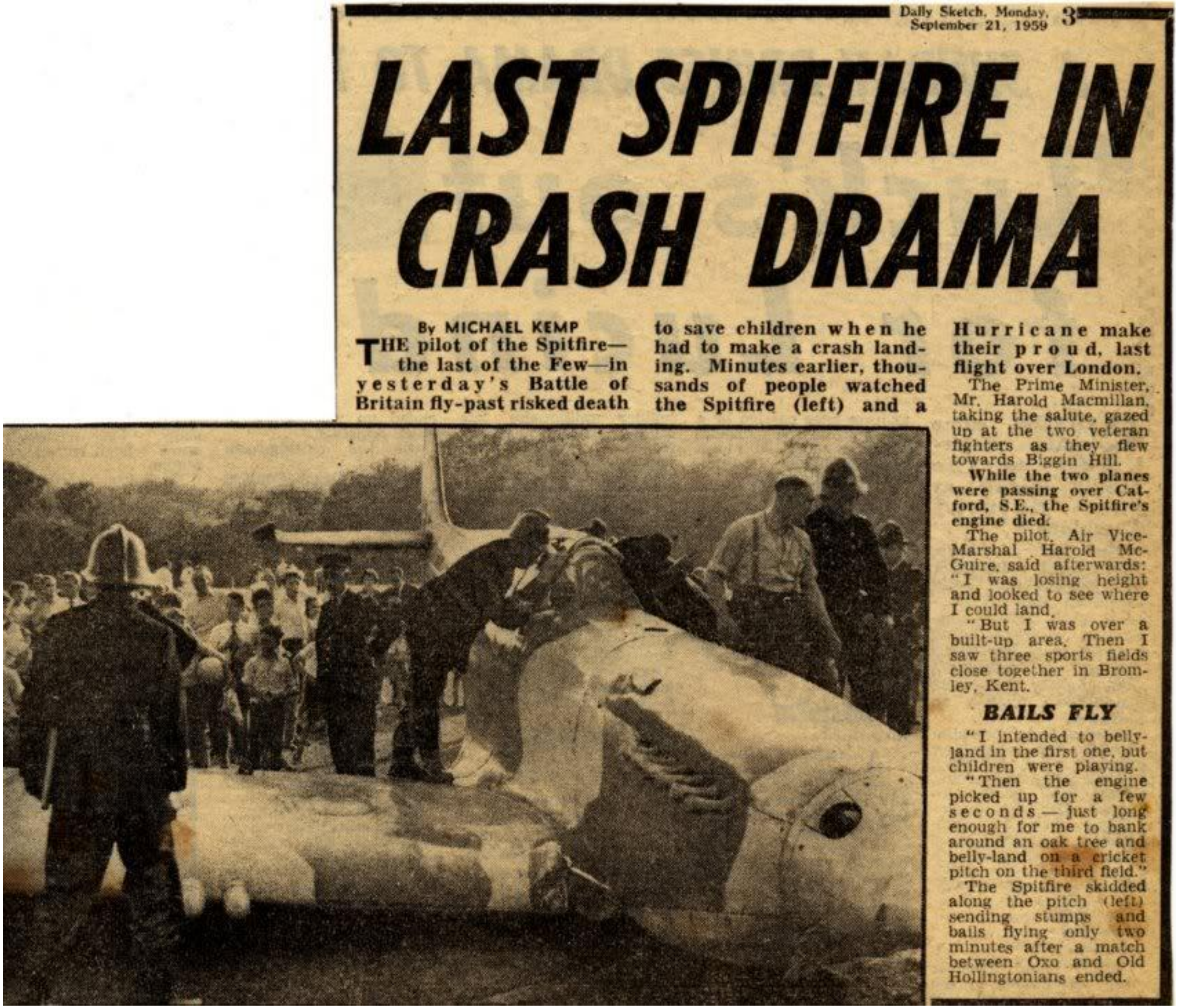

Daily Sketch, Monday, September 21, 1959 3

LAST SPITFIRE IN CRASH DRAMA

By MICHAEL KEMP

THE pilot of the Spitfire—the last of the Few—in yesterday's Battle of Britain fly-past risked death to save children when he had to make a crash landing. Minutes earlier, thousands of people watched the Spitfire (left) and a Hurricane make their proud, last flight over London.

The Prime Minister, Mr. Harold Macmillan, taking the salute, gazed up at the two veteran fighters as they flew towards Biggin Hill.

While the two planes were passing over Catford, S.E., the Spitfire's engine died.

The pilot, Air Vice-Marshal Harold McGuire, said afterwards: "I was losing height and looked to see where I could land.

"But I was over a built-up area. Then I saw three sports fields close together in Bromley, Kent.

BAILS FLY

"I intended to belly-land in the first one, but children were playing.

"Then the engine picked up for a few seconds — just long enough for me to bank around an oak tree and belly-land on a cricket pitch on the third field."

The Spitfire skidded along the pitch (left) sending stumps and bails flying only two minutes after a match between Oxo and Old Hollingtonians ended.

Sep 21, 1959, UK Newspaper article about the **last flight of SDASM's artifact Spitfire**. Notice **three dents** in leading edge of right wing where the **three bails (stumps) of the wicket left their mark** after the Spit's wing hit them during emergency landing.

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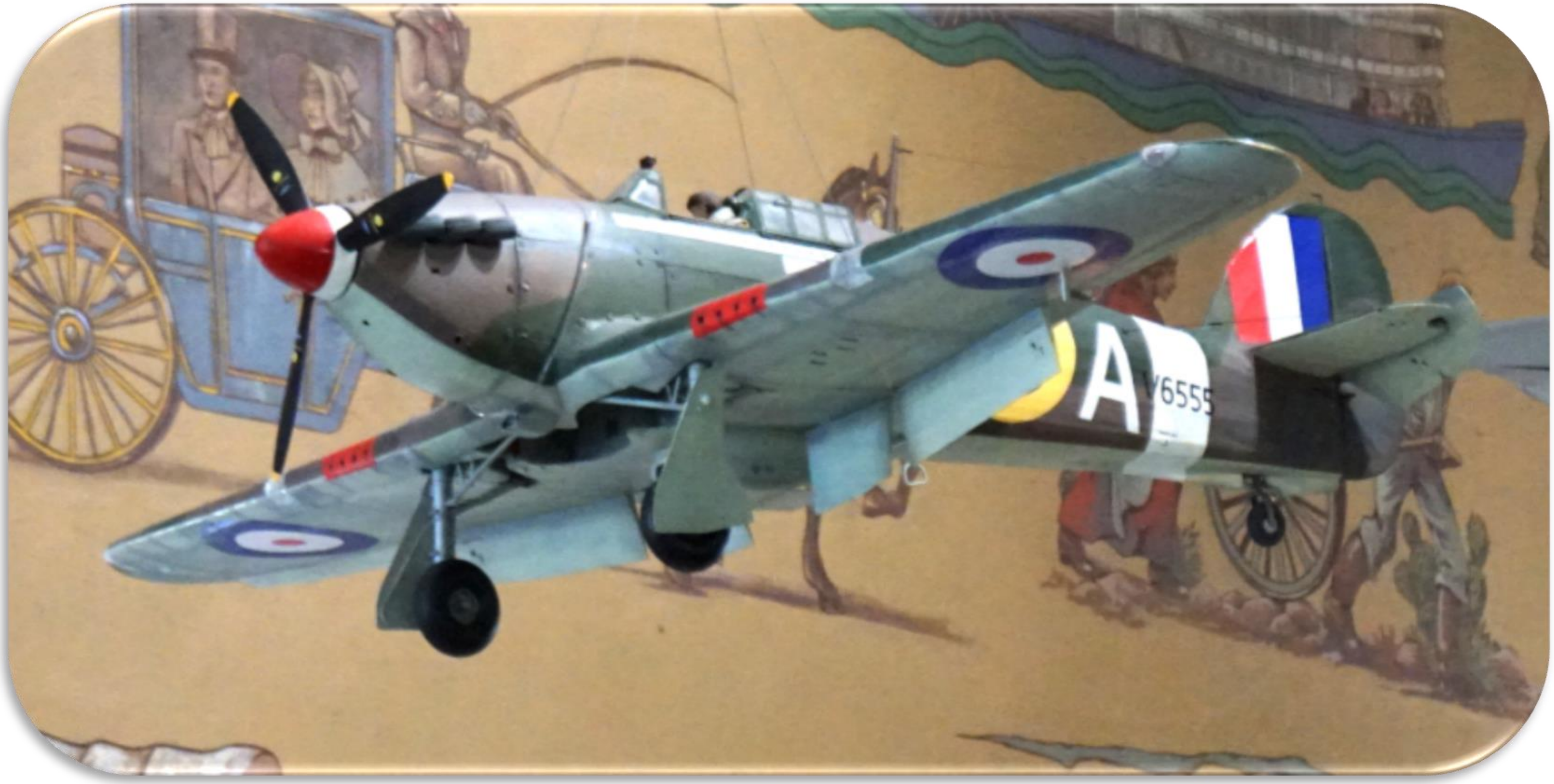

1st flight: 1937 (14,487 Built)

Key Points: The **Hawker Hurricane** (Model) is a British single-seat fighter aircraft of the 1930s–40s that was designed by Sir Sydney Camm and built by Hawker Aircraft Ltd. Built with a three blade two-pitch propeller, powered by the **1,030 hp Rolls-Royce Merlin** Mk II or III engines and armed with **eight .303 Browning machine guns**. Produced between 1937 and 1939. It was overshadowed in the public consciousness by the Supermarine Spitfire's role during the Battle of Britain in 1940, but the **Hurricane inflicted 60 per cent of the losses sustained by the Luftwaffe** in the engagement, and fought in all the major theatres of the Second World War.

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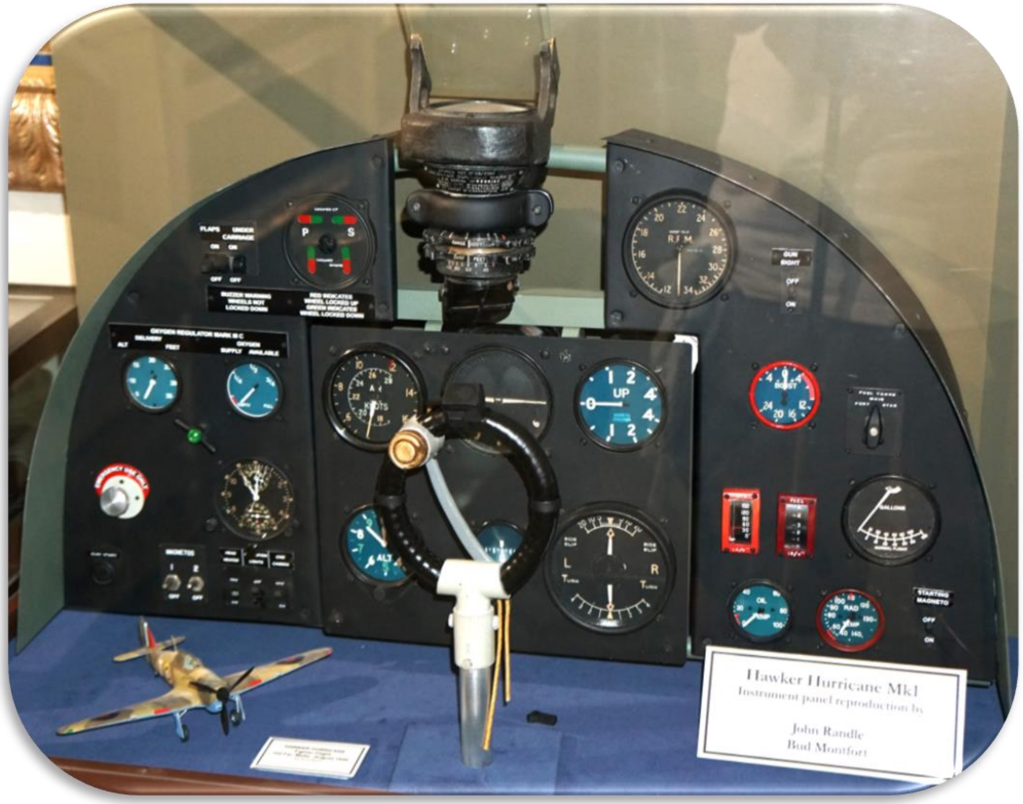
Hawker Hurricane MkI
Instrument panel reproduction by
John Randle
Bud Montfort

General	Spitfire	Hurricane
Crew:	1	1
Length:	29 ft 11 in	32 ft 2 in
Wingspan:	36 ft 10 in	40 ft
Gross weight:	5,065 lb	7,670 lb
Powerplant:	RR Merlin 45 @1,470 hp	RR Merlin XX @1185 hp
Number built:	20,351	14,487
Years built:	1938-1948	1937-1944
Performance		
Maximum speed:	370 mph	340 mph
Range:	479 mi	600 mi
Service ceiling:	36,500 ft	36,000 ft
Armament		
Guns: A wing	8x.303 caliber	4 × 20 mm
Guns: C wing	4x20 mm	
Guns: E wing	2x.50 Cal & 2x20 mm	

Hawker Hurricane Instrument Panel (Reproduction) built by John Randle and Bud Montfort.

Comparison of Supermarine’s Spitfire and Hawker Hurricane.

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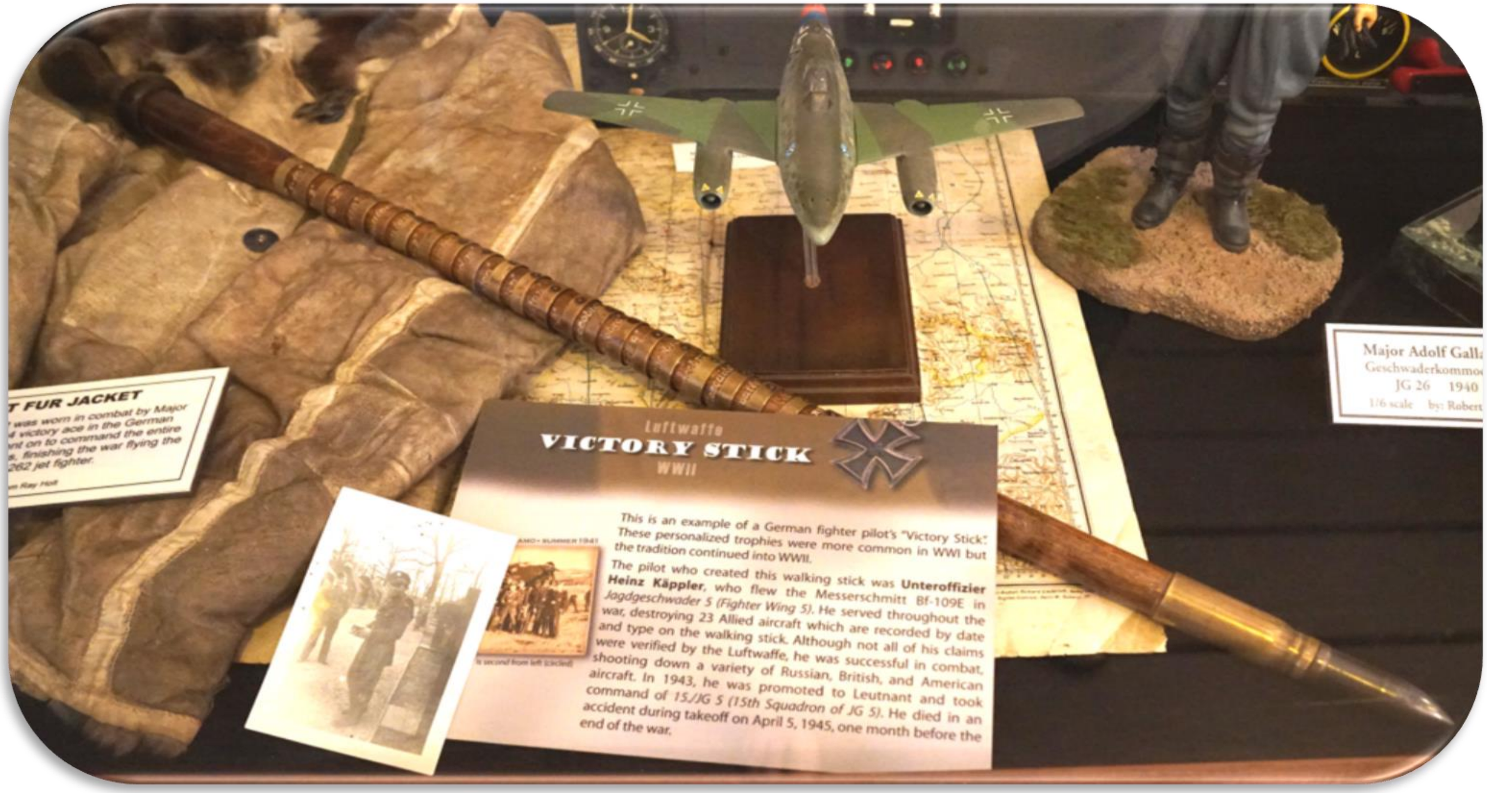

Luftwaffe
VICTORY STICK
WWII

This is an example of a German fighter pilot's "Victory Stick." These personalized trophies were more common in WWI but the tradition continued into WWII.

The pilot who created this walking stick was **Unteroffizier Heinz Käppler**, who flew the Messerschmitt Bf-109E in *Jagdgeschwader 5 (Fighter Wing 5)*. He served throughout the war, destroying 23 Allied aircraft which are recorded by date and type on the walking stick. Although not all of his claims were verified by the Luftwaffe, he was successful in combat, shooting down a variety of Russian, British, and American aircraft. In 1943, he was promoted to Leutnant and took command of *15./JG 5 (15th Squadron of JG 5)*. He died in an accident during takeoff on April 5, 1945, one month before the end of the war.

T FUR JACKET
was worn in combat by Major
victory ace in the German
nt on to command the entire
s, finishing the war flying the
262 jet fighter.
Major Adolf Galla
Geschwaderkommo
JG 26 1940
1/6 scale by: Robert

Key Points: **WWII German Victory Stick (Original)**. Belonged to Unteroffizier **Heinz Käppler** who flew the **Messerschmitt Bf-109E** in Jagdgeschwader 5 (Fighter Wing 5). He served throughout the war, **destroying 23 Allied aircraft** which are recorded by **date and type** on the walking stick. In 1943, he was promoted to Leutnant and took command of 15./JG 5 (15th Squadron of Fighter Wing 5). He was killed in a takeoff crash on April 5, 1945, one month before the end of the war. In the small picture, he is the pilot **without** his stick; his girlfriend was keeping it and that is how it survived.

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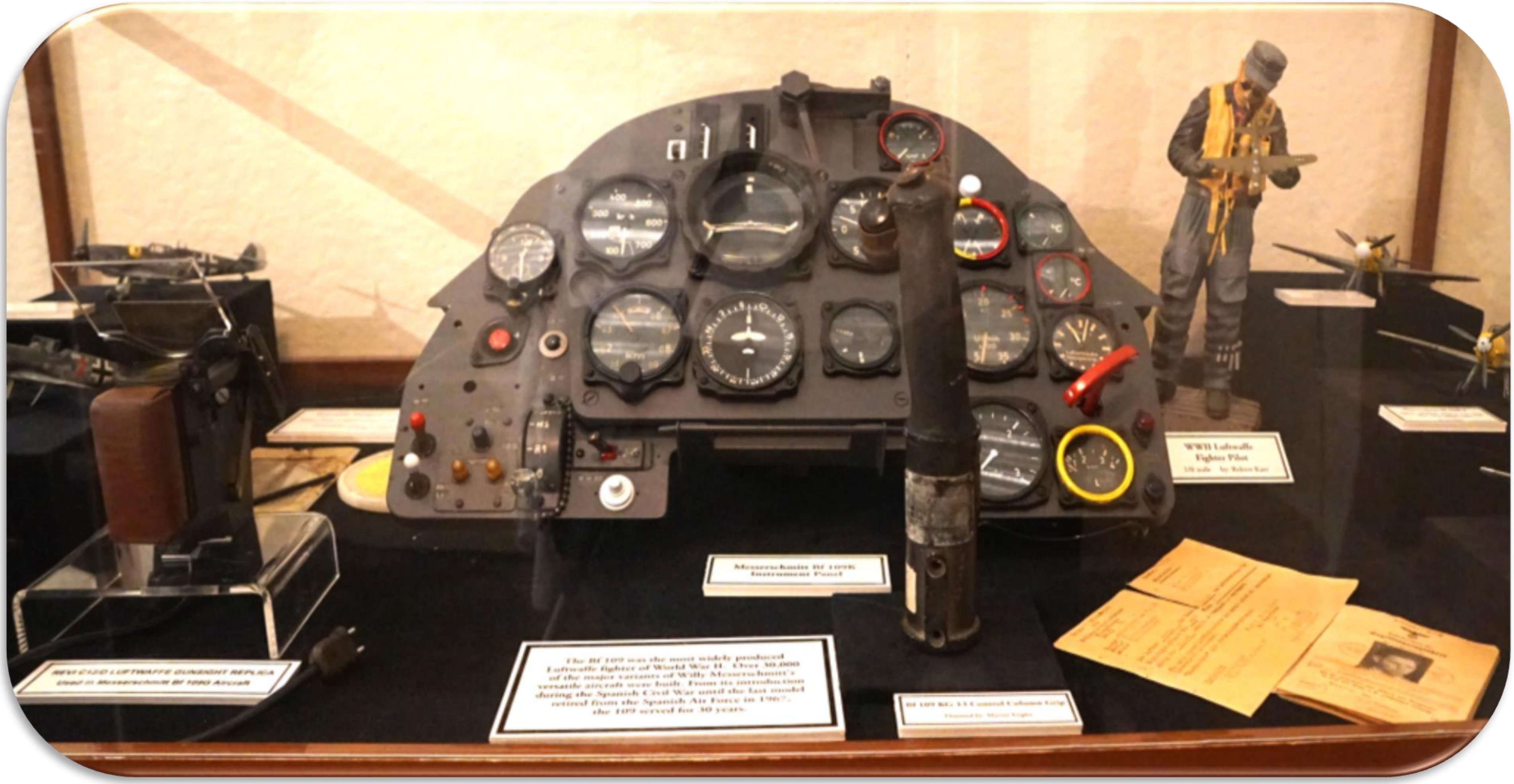
World War II Gallery


Messerschmitt Bf 109K Instrument Panel
WWII Luftwaffe Fighter Pilot

Messerschmitt Bf 109K instrument panel, control stick, models and memorabilia.

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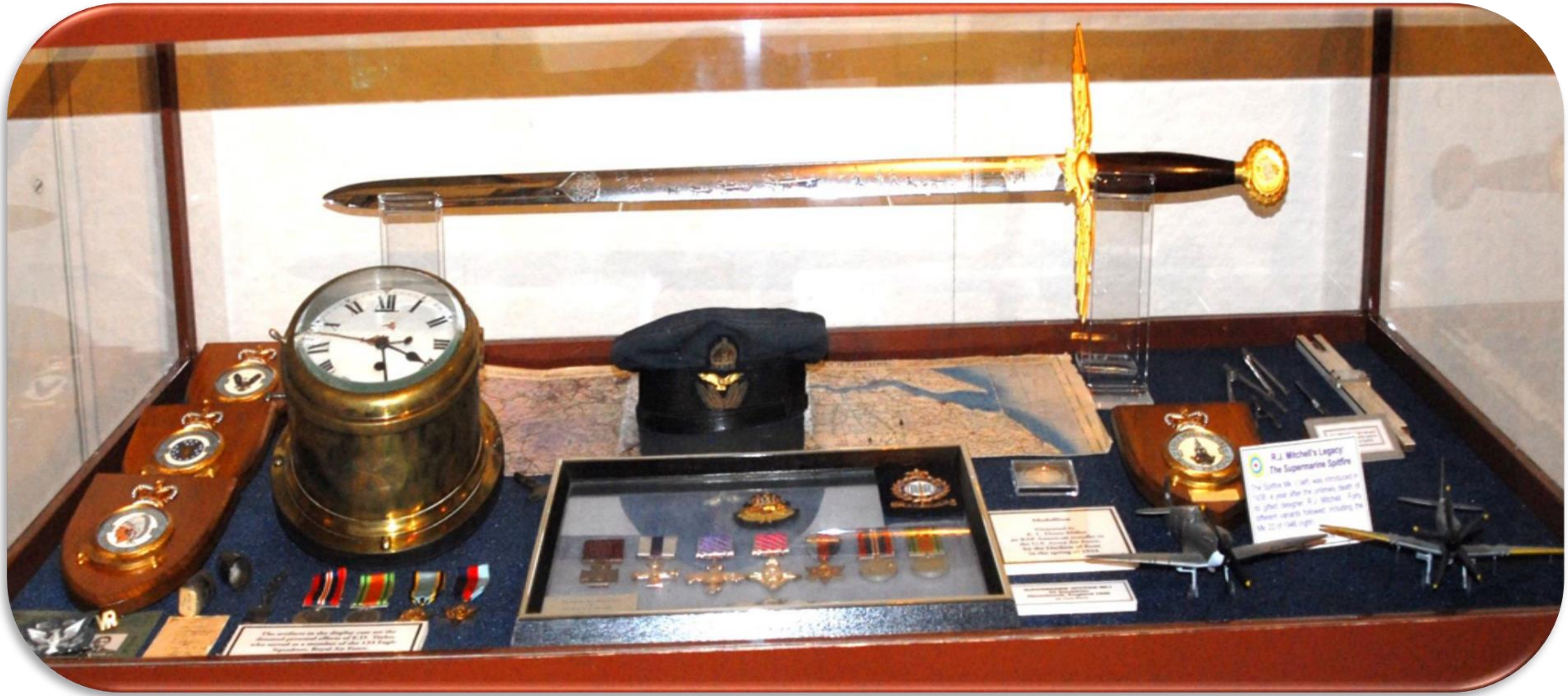

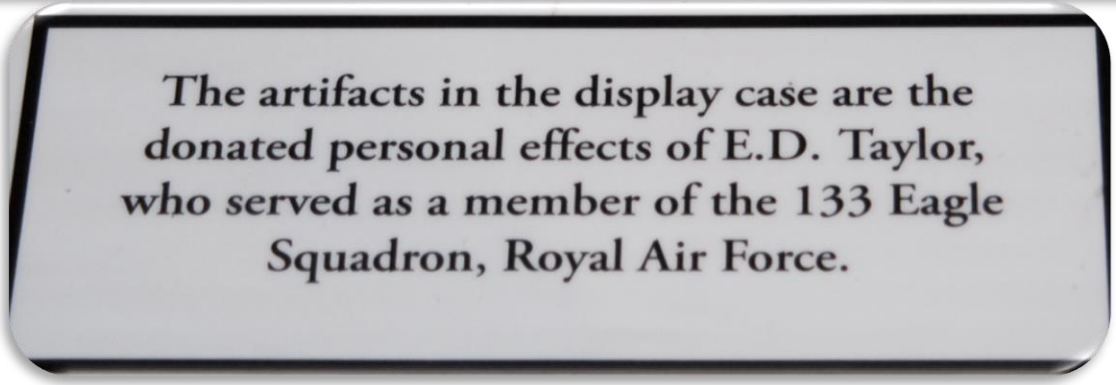

The artifacts in the display case are the donated personal effects of E.D. Taylor, who served as a member of the 133 Eagle Squadron, Royal Air Force.

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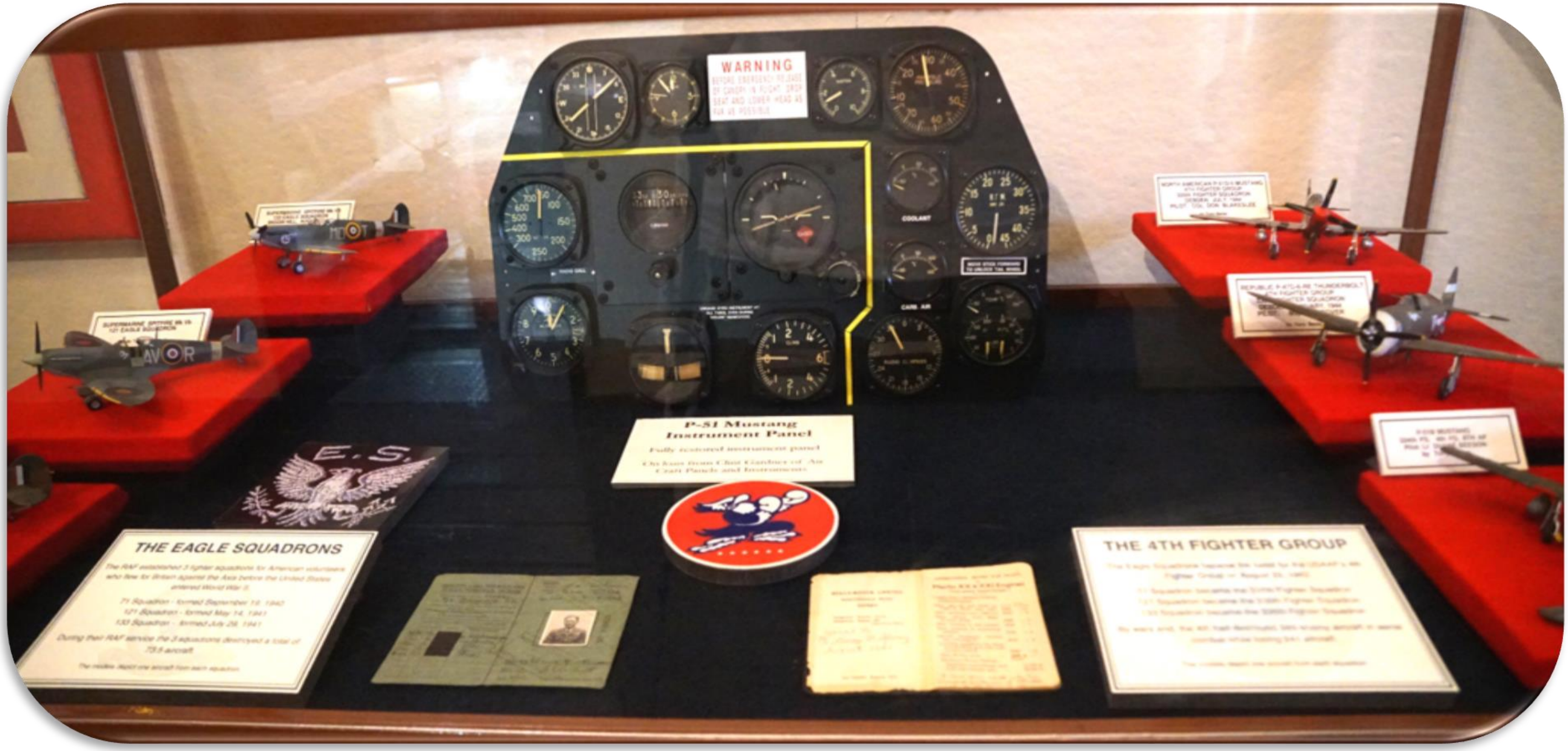
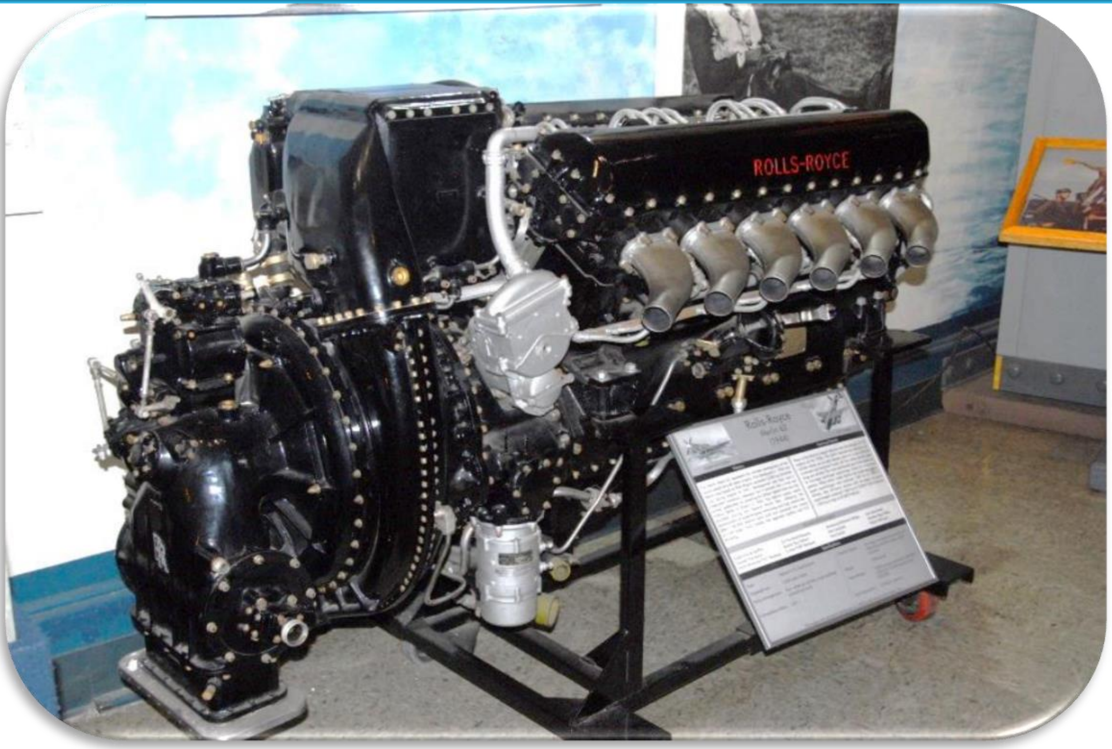
World War II Gallery


WARNING
P-51 Mustang
Instrument Panel
E.S.
THE EAGLE SQUADRONS
THE 4TH FIGHTER GROUP

P-51 Mustang instrument panel, models and memorabilia display.



1st Run: 1933
(168,000+ built)

Key Points:

Rolls-Royce Merlin British liquid-cooled, V-12, piston engine (1,650 cu in). After several modifications, **1st production engines built in 1936**. 1st operational aircraft using the Merlin were the **Fairey Battle, Hawker Hurricane and Supermarine Spitfire**. Most Merlin engines were made for the four-engine **Avro Lancaster heavy bomber**; however, the engine is most closely associated with the Spitfire & Hurricane. The **Packard V-1650** was a version of the Merlin built in the United States (1941), and was the primary engine used in the later version **North American P-51D Mustang**. Production ceased in 1956 after almost **168,000 engines** had been delivered, the later variants being used for airliners and military transport aircraft.

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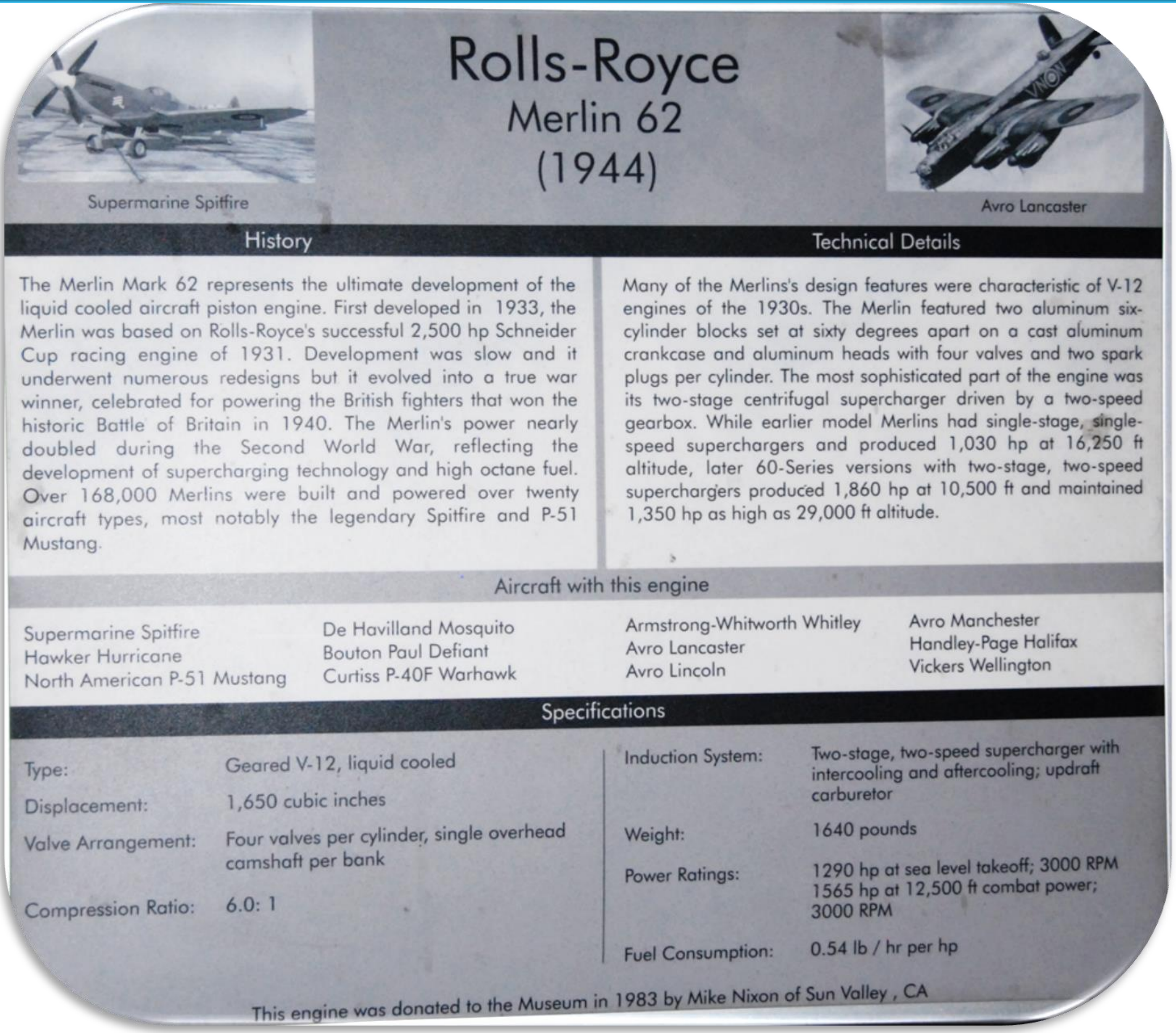
World War II Gallery



Rolls-Royce
Merlin 62
(1944)

Supermarine Spitfire

Avro Lancaster

History

The Merlin Mark 62 represents the ultimate development of the liquid cooled aircraft piston engine. First developed in 1933, the Merlin was based on Rolls-Royce's successful 2,500 hp Schneider Cup racing engine of 1931. Development was slow and it underwent numerous redesigns but it evolved into a true war winner, celebrated for powering the British fighters that won the historic Battle of Britain in 1940. The Merlin's power nearly doubled during the Second World War, reflecting the development of supercharging technology and high octane fuel. Over 168,000 Merlins were built and powered over twenty aircraft types, most notably the legendary Spitfire and P-51 Mustang.

Technical Details

Many of the Merlins's design features were characteristic of V-12 engines of the 1930s. The Merlin featured two aluminum six-cylinder blocks set at sixty degrees apart on a cast aluminum crankcase and aluminum heads with four valves and two spark plugs per cylinder. The most sophisticated part of the engine was its two-stage centrifugal supercharger driven by a two-speed gearbox. While earlier model Merlins had single-stage, single-speed superchargers and produced 1,030 hp at 16,250 ft altitude, later 60-Series versions with two-stage, two-speed superchargers produced 1,860 hp at 10,500 ft and maintained 1,350 hp as high as 29,000 ft altitude.

Aircraft with this engine

Supermarine Spitfire
Hawker Hurricane
North American P-51 Mustang
De Havilland Mosquito
Bouton Paul Defiant
Curtiss P-40F Warhawk
Armstrong-Whitworth Whitley
Avro Lancaster
Avro Lincoln
Avro Manchester
Handley-Page Halifax
Vickers Wellington

Specifications

Type:	Geared V-12, liquid cooled
Displacement:	1,650 cubic inches
Valve Arrangement:	Four valves per cylinder, single overhead camshaft per bank
Compression Ratio:	6.0: 1
Induction System:	Two-stage, two-speed supercharger with intercooling and aftercooling; updraft carburetor
Weight:	1640 pounds
Power Ratings:	1290 hp at sea level takeoff; 3000 RPM 1565 hp at 12,500 ft combat power; 3000 RPM
Fuel Consumption:	0.54 lb / hr per hp

This engine was donated to the Museum in 1983 by Mike Nixon of Sun Valley , CA

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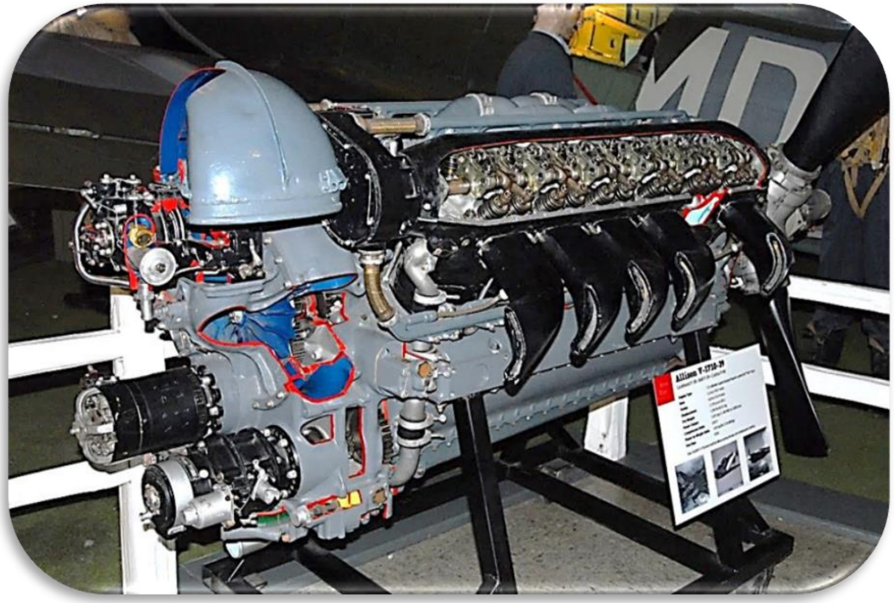
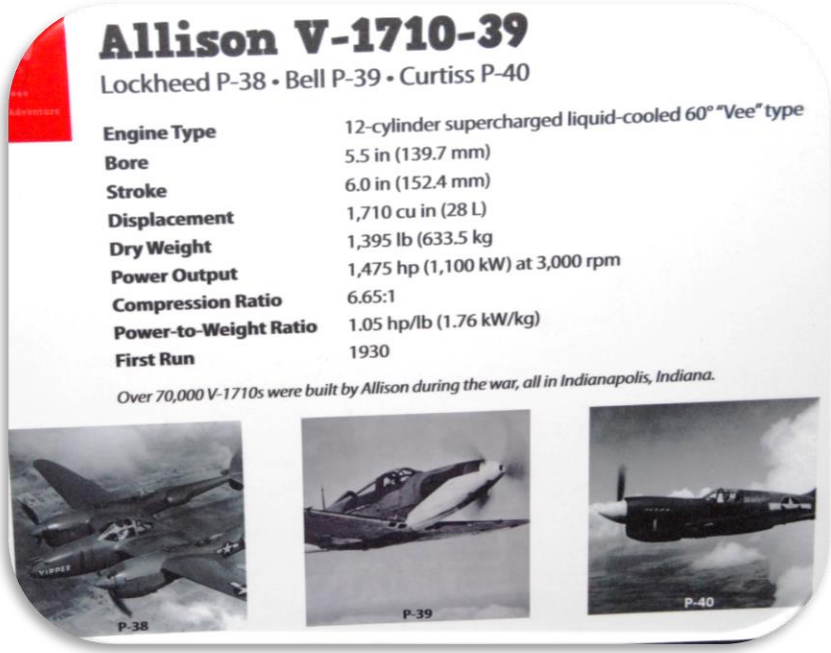
World War II Gallery



1st Run: 1930
(70,000+ built)



Allison V-1710-39

Lockheed P-38 • Bell P-39 • Curtiss P-40

Engine Type	12-cylinder supercharged liquid-cooled 60° "Vee" type
Bore	5.5 in (139.7 mm)
Stroke	6.0 in (152.4 mm)
Displacement	1,710 cu in (28 L)
Dry Weight	1,395 lb (633.5 kg
Power Output	1,475 hp (1,100 kW) at 3,000 rpm
Compression Ratio	6.65:1
Power-to-Weight Ratio	1.05 hp/lb (1.76 kW/kg)
First Run	1930

Over 70,000 V-1710s were built by Allison during the war, all in Indianapolis, Indiana.

P-38

P-39

P-40

Key Points: **Allison V-1710, (1930) only US developed V-12 liquid-cooled engine in WWII**. Versions with turbosuperchargers gave excellent performance (compared with normally aspirated engines) at high altitude in the twin-engined Lockheed P-38 Lightning. Over **70,000 engines produced from 1931 to 1948**. Used in WWII fighters including the **P-38 Lightning , P-39 Airacobra, P-40 Warhawk, P-51A Mustang, P-63 Kingcobra, P-82 Twin Mustang & Consolidated XA-11A**.

Turbo is single speed and smaller than Merlin, therefore the **Allison did not perform as well at high altitudes as the Merlin, however it was somewhat more reliable**.

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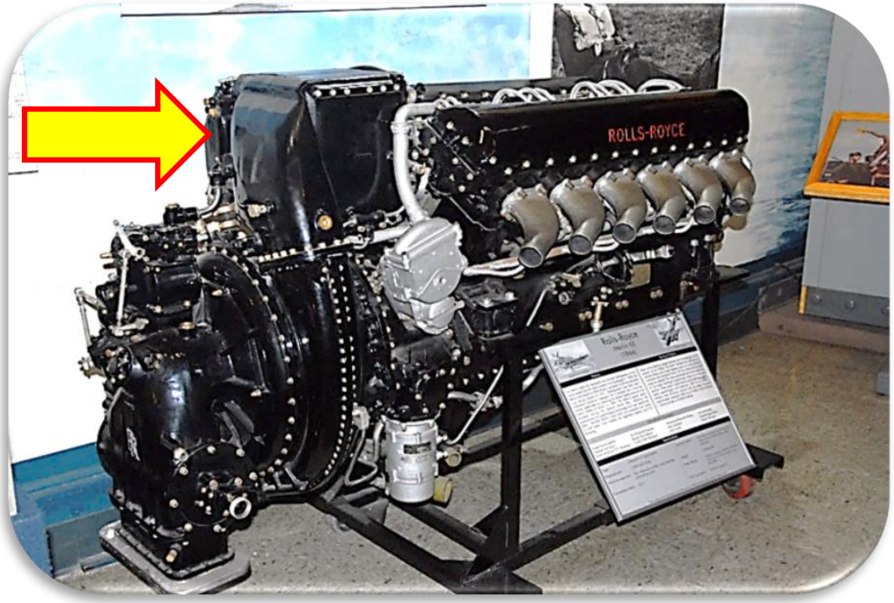
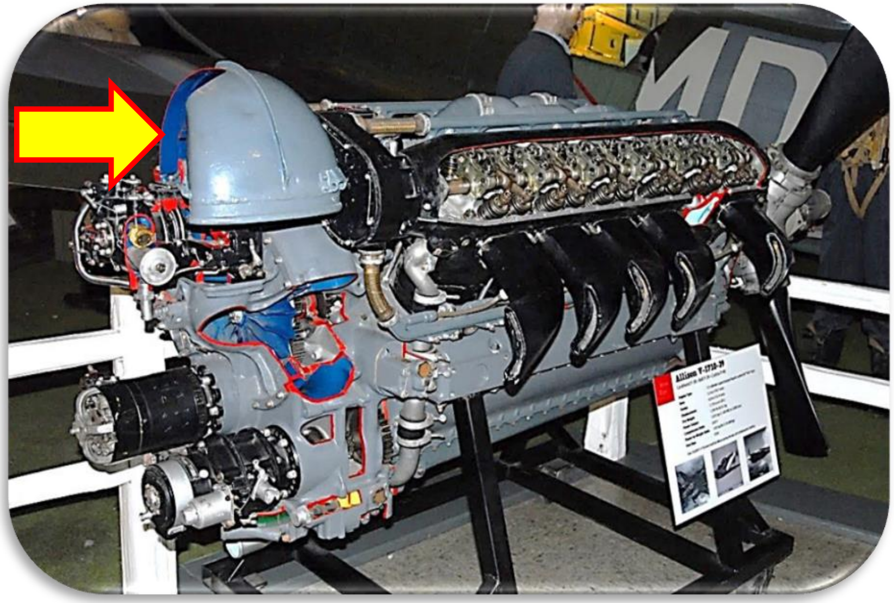
World War II Gallery

Rolls-Royce Merlin



Allison V-1710



Key Points: Rolls-Royce Merlin Vs Allison. Notice how much larger the **Rolls-Royce Merlin (left)** two speed supercharger is than the **Allison V-1710 (right)** single speed supercharger, giving the **Rolls-Royce Merlin much better high altitude performance**. This difference resulted in later versions of the P-51 Mustang using the **Packard V-1650 version of the Rolls-Royce Merlin engine.**

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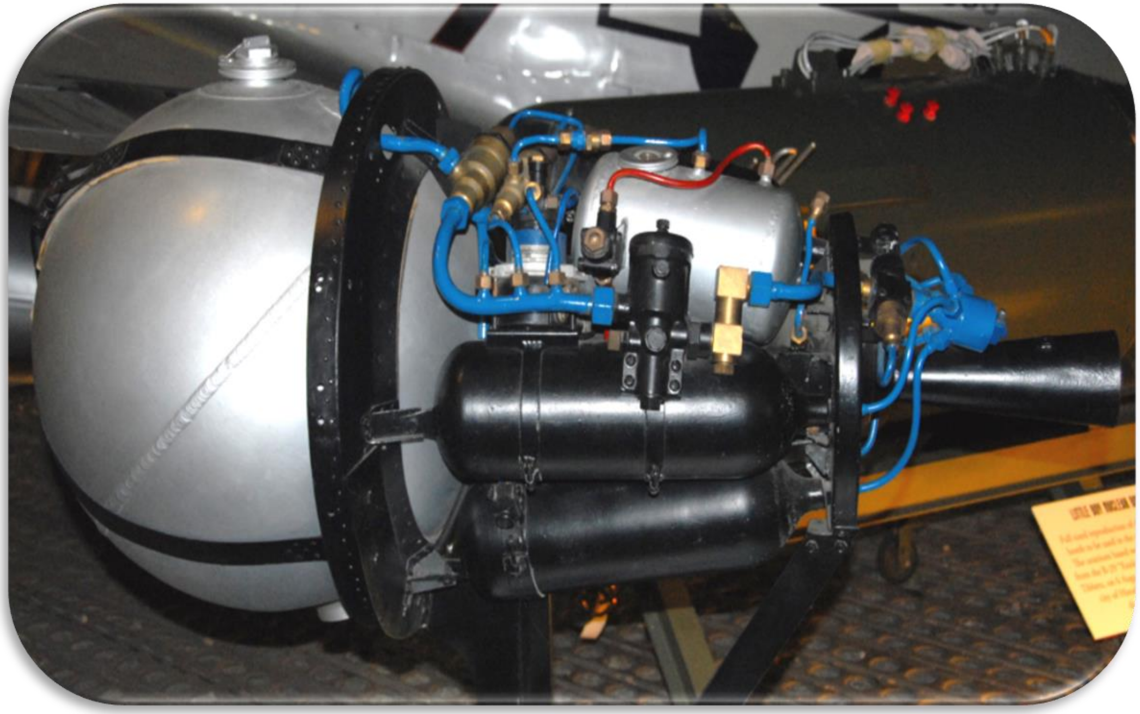
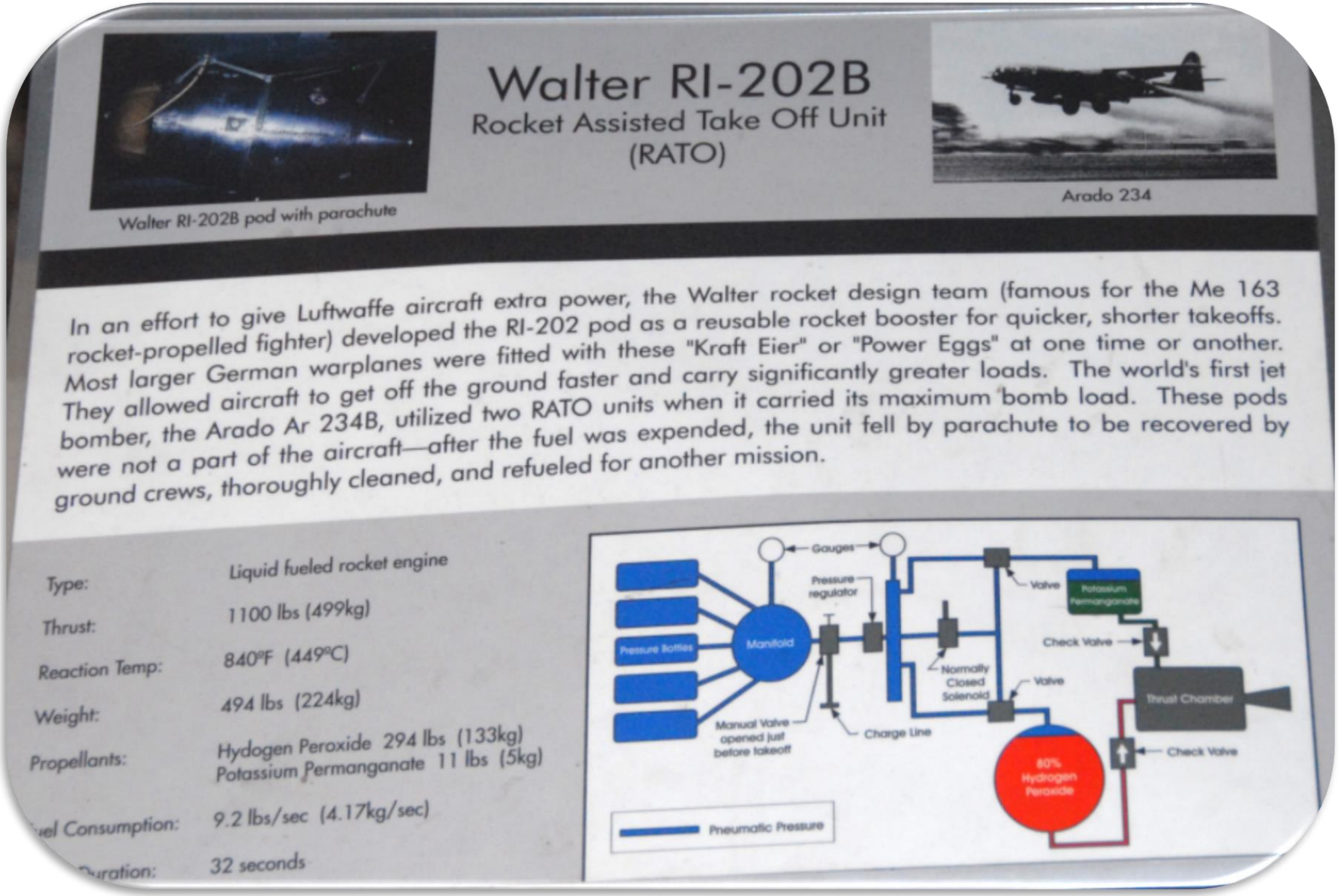
World War II Gallery



1st Run: WWII

This: Walter RI-202B RATO (Original) - Rocket Assisted Take Off unit for Luftwaffe WWII aircraft (Arado AR-234B). Each Arado used 2 liquid fueled Rocket Assisted Take Off units. Each unit provided **1100 pounds of thrust** using 294 lb Hydrogen Peroxide and 11 lb Potassium Permanganate. Each unit fired for **32 seconds**.

World War II Gallery



Walter RI-202B pod with parachute

Walter RI-202B

Rocket Assisted Take Off Unit (RATO)

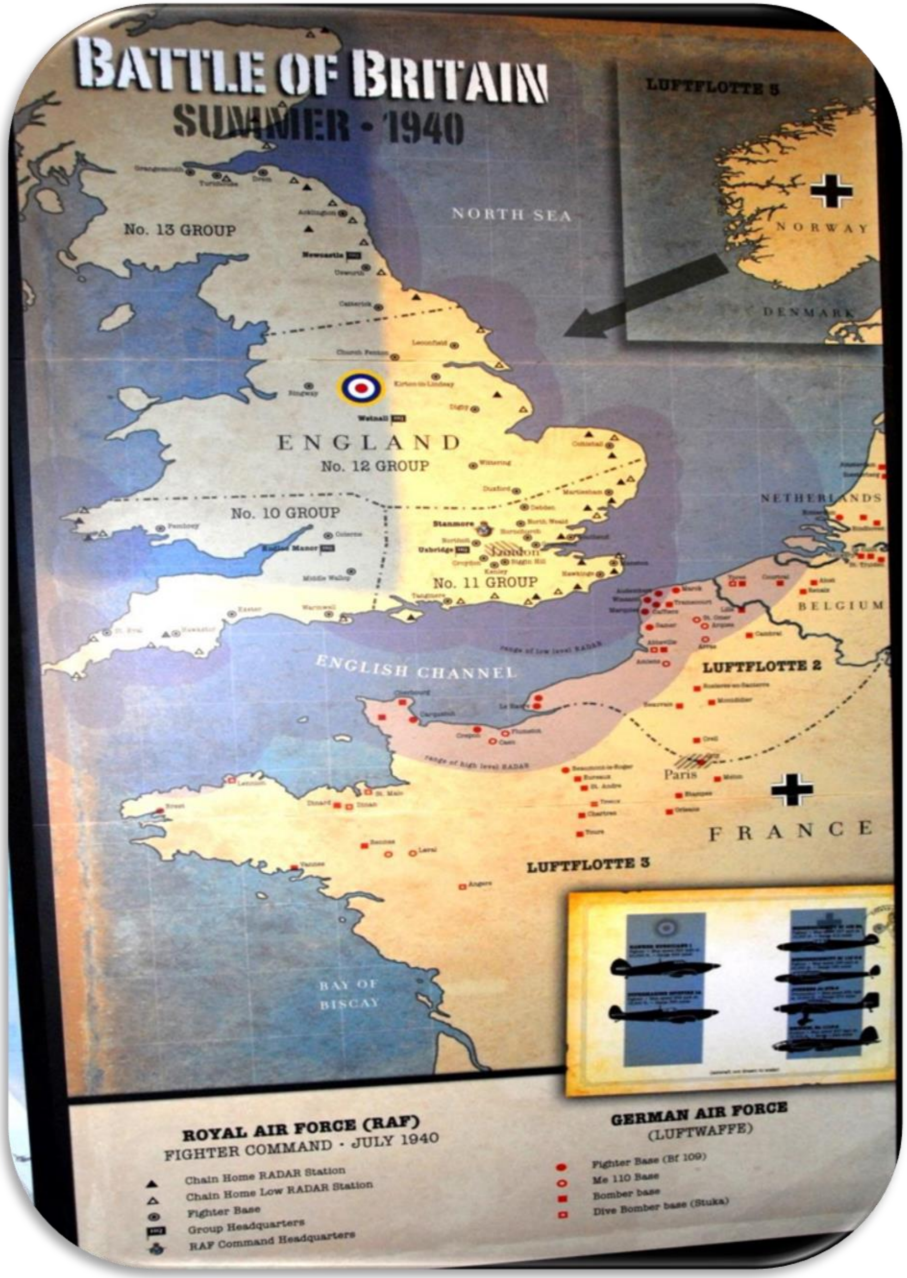
Arado 234

In an effort to give Luftwaffe aircraft extra power, the Walter rocket design team (famous for the Me 163 rocket-propelled fighter) developed the RI-202 pod as a reusable rocket booster for quicker, shorter takeoffs. Most larger German warplanes were fitted with these "Kraft Eier" or "Power Eggs" at one time or another. They allowed aircraft to get off the ground faster and carry significantly greater loads. The world's first jet bomber, the Arado Ar 234B, utilized two RATO units when it carried its maximum bomb load. These pods were not a part of the aircraft—after the fuel was expended, the unit fell by parachute to be recovered by ground crews, thoroughly cleaned, and refueled for another mission.

Type:	Liquid fueled rocket engine
Thrust:	1100 lbs (499kg)
Reaction Temp:	840ºF (449ºC)
Weight:	494 lbs (224kg)
Propellants:	Hydogen Peroxide 294 lbs (133kg) Potassium Permanganate 11 lbs (5kg)
el Consumption:	9.2 lbs/sec (4.17kg/sec)
uration:	32 seconds

Gauges
Pressure regulator
Valve
Potassium Permanganate
Check Valve
Pressure Bottles
Manifold
Normally Closed Solenoid
Valve
Thrust Chamber
Manual Valve opened just before takeoff
Charge Line
Check Valve
80% Hydrogen Peroxide
Pneumatic Pressure

World War II Gallery


BATTLE OF BRITAIN
SUMMER · 1940
LUFTFLOTTE 5
NORTH SEA
NORWAY
DENMARK
No. 13 GROUP
ENGLAND
No. 12 GROUP
No. 10 GROUP
No. 11 GROUP
London
NETHERLANDS
BELGIUM
ENGLISH CHANNEL
LUFTFLOTTE 2
Paris
FRANCE
LUFTFLOTTE 3
BAY OF BISCAY
ROYAL AIR FORCE (RAF)
FIGHTER COMMAND · JULY 1940
▲ Chain Home RADAR Station
△ Chain Home Low RADAR Station
◉ Fighter Base
Group Headquarters
RAF Command Headquarters
GERMAN AIR FORCE
(LUFTWAFFE)
● Fighter Base (Bf 109)
○ Me 110 Base
■ Bomber base
□ Dive Bomber base (Stuka)

Key Points: Battle of Britain Jul 10, 1940 – Oct 31, 1940 (**114 days**). **Note:** German historians cite **Jul 1940 to Jun 1941 (1 Year)**. Royal Air Forces defended the UK against attacks by the German Air Force (Luftwaffe). The **first major military campaign fought entirely by air forces**. Principally fought between the British **Supermarine Spitfire & Hawker Hurricane** and the German **Messerschmitt Bf 109**. Noted historians regard the German failure to destroy Britain's air defenses as the **first major defeat of Nazi Germany in World War II** and a **crucial turning point in the conflict in Europe**.

Britain lost: 1542 aircrew killed, 422 aircrew wounded and 1,744 aircraft destroyed. Around 35,000 civilians killed and wounded.

Germany lost: 2,585 aircrew killed, 925 captured, 735 wounded and 1,977 aircraft destroyed.

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World War II Gallery

The LUFTWAFFE
BATTLE OF BRITAIN

Key Points: **Luftwaffe.** In 1940, the Luftwaffe was the **largest air force in Europe**, however its **lack of heavy bombers**, no method to **track aircraft positions**, lack of **ground-to-air communication** (across the channel) with its aircraft, aircraft **parts supply problems** and a **lack of aircraft and pilot** reserves contributed to their defeat during the Battle of Britain.

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World War II Gallery

DENMARK
NETHERLANDS
BELGIUM
LUFTFLOTTE 2
FRANCE
TFLOTTE 3
The ROYAL AIR FORCE
GERMAN AIR FORCE
(LUFTWAFFE)

Key Points: Royal Air Force. Outnumbered by **2600 German** aircraft to **640 British** initially, the RAFs higher quality of equipment, training and morale proved superior. While the **Luftwaffe had no strategic plan**, the RAFs superb **organization, tactical control and radar** were used to the maximum advantage. The victory was as much psychological as physical.

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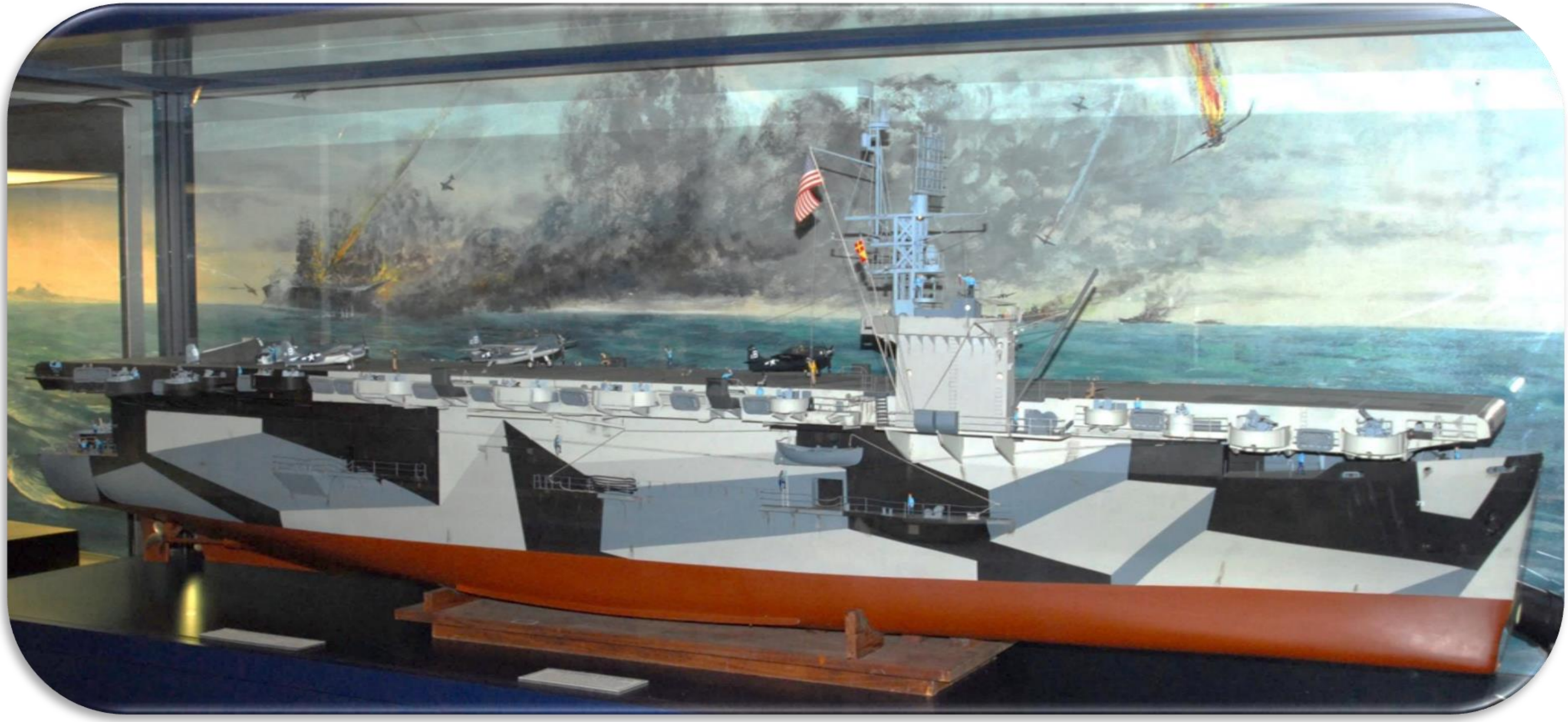
Aircraft Carriers



USS *Gambier Bay* (CVE-73) a *Casablanca*-class escort carrier of the US Navy. She was the only American aircraft carrier **sunk by enemy surface gunfire** during WWII. Commissioned **Dec 28, 1943**. **Carried 28 aircraft**. **Sunk Oct 25, 1944,** in the **Battle off Samar** during **Battle of Leyte Gulf** after helping to turn back a much larger attacking Japanese surface force. **Presidential Unit Citation; 4 Battle stars.**

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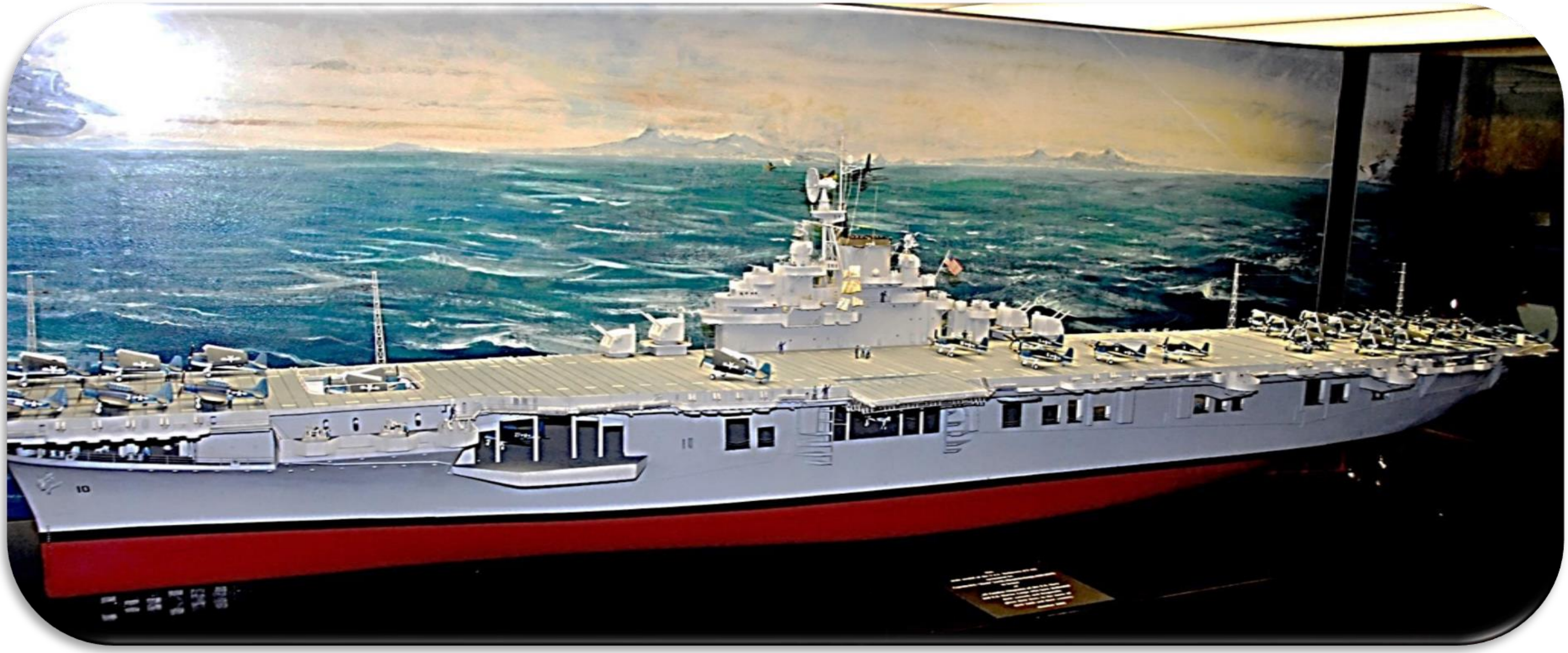
World War II Gallery



USS Yorktown (CV-10) one of 24 *Essex*-class aircraft carriers during WW II for the US Navy. **Carried 90 to 100 aircraft**. Named after Battle of Yorktown, American Revolutionary War, was the **fourth Navy ship to bear the name**. She was **renamed *Yorktown* while under construction to commemorate USS *Yorktown* (CV-5), lost at the Battle of Midway** in June, 1942. *Yorktown* was **commissioned in April, 1943**, and participated in several campaigns in the Pacific Theater of Operations, earning **11 battle stars** and the **Presidential Unit Citation**. Decommissioned **Jun 27, 1970**.

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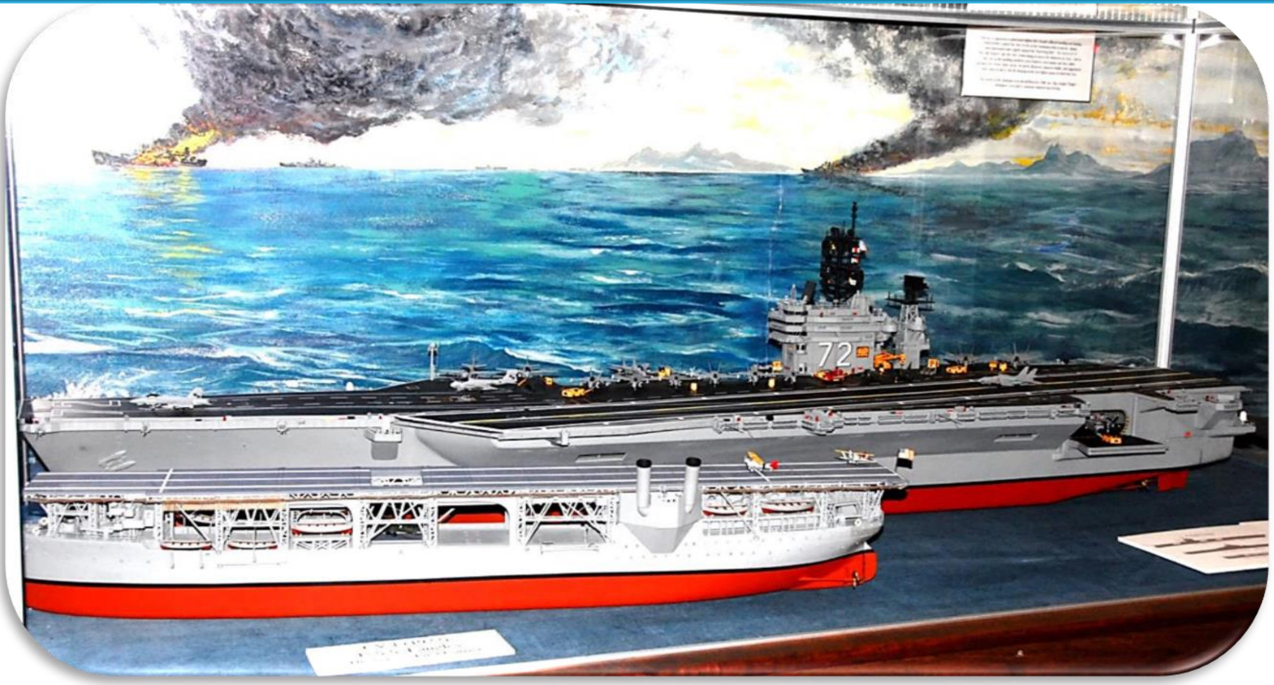
World War II Gallery

1920

1989



Then

Now

USS Langley (CV-1) **US Navy's first aircraft carrier**, converted **1920** from the collier **USS *Jupiter*.** US Navy's first **turbo-electric-powered** ship.
Length: 542 feet,
Speed: 15.5 knots,
Range: 3500 nautical miles,
Aircraft carried: 36,
Complement: 468 man crew.
Decommissioned May 8, 1942.

USS Lincoln (CVN-72) **5th *Nimitz-class*** aircraft carrier in the US Navy. Second Navy ship named Abraham Lincoln. Commissioned **Nov 11, 1989**.
Length: 1092 feet,
Speed: 30+ knots,
Range: Unlimited distance - 20 to 25 years,
Aircraft carried: 90 Fixed & Rotary Wing,
Complement: 3200 crew ship + 2480 air,
On active duty.

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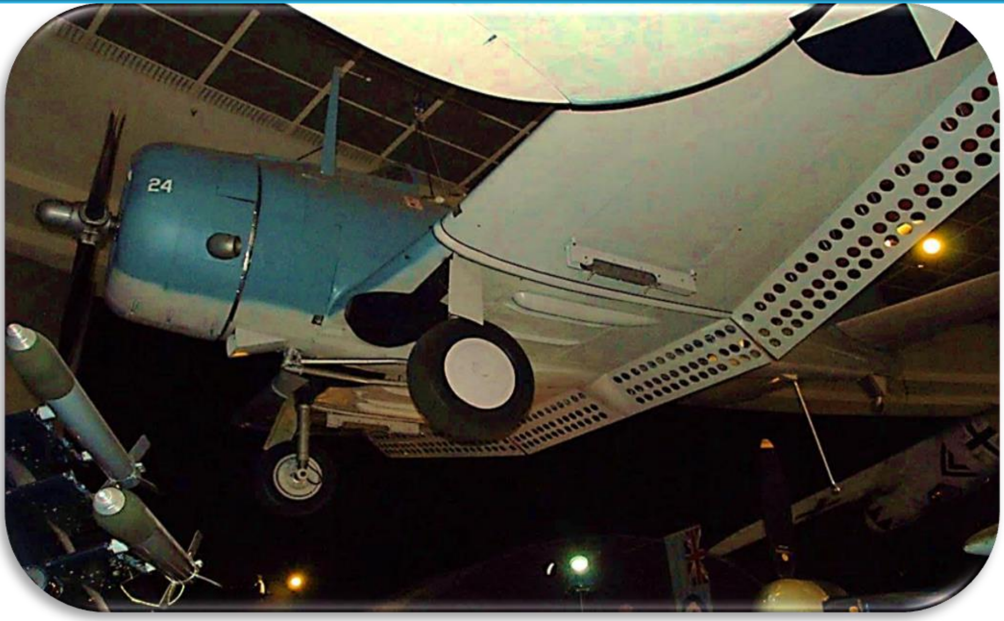

1st flight: 1940
(5936 built)

Key Points:

Douglas SBD-4 Dauntless (Original). Designed as **both a scout and dive bomber**. Added to Navy fleet **1940, 5936 produced**. **Changed the tactics of naval warfare**. Sank small Japanese carrier and severely damaged heavy carrier in the May, 1942, **Battle of the Coral Sea**. In the **Battle of Midway**, June, 1942, SBD Dauntless squadrons destroyed four Japanese carriers: **Kaga, Akagi, Soryu, and Hiryu**. Used against Germany as well. SBDs credited with sinking **18 enemy warships** and **shooting down 138 Japanese aircraft**. Phased out of carrier ops by July 1944, the SBD continued service with the Marines on land bases until the war's end.

This: One of **780** built by Douglas, attached to USS Sable for carrier training. It sank to the bottom of **Lake Michigan as a result of engine failure** on June 26, 1943. Recovered by National Museum of Naval Aviation in 1993. 4 year restoration. Painted like VB-16, when squadron was attached to the USS Lexington in 1943.

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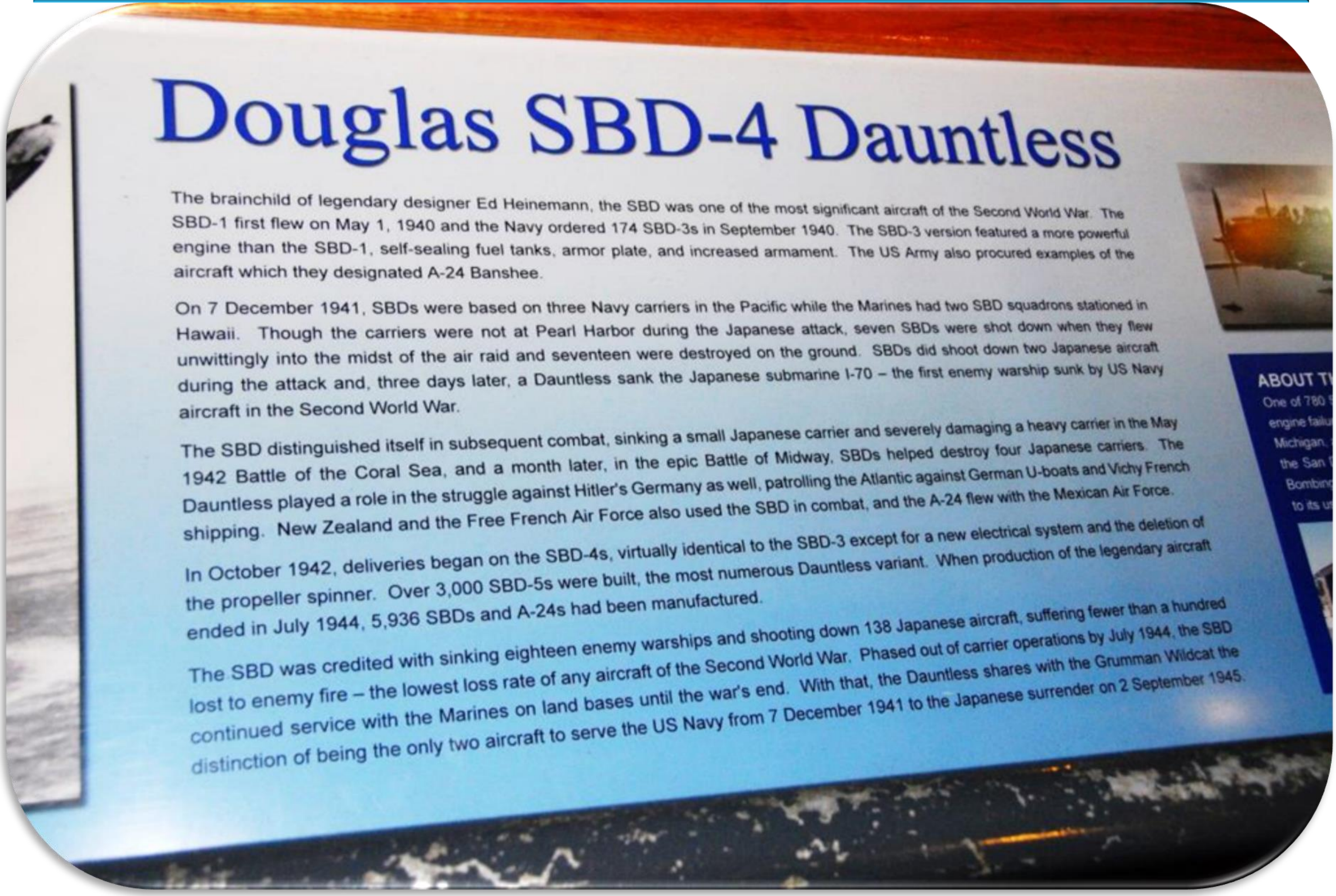

Douglas SBD-4 Dauntless

The brainchild of legendary designer Ed Heinemann, the SBD was one of the most significant aircraft of the Second World War. The SBD-1 first flew on May 1, 1940 and the Navy ordered 174 SBD-3s in September 1940. The SBD-3 version featured a more powerful engine than the SBD-1, self-sealing fuel tanks, armor plate, and increased armament. The US Army also procured examples of the aircraft which they designated A-24 Banshee.

On 7 December 1941, SBDs were based on three Navy carriers in the Pacific while the Marines had two SBD squadrons stationed in Hawaii. Though the carriers were not at Pearl Harbor during the Japanese attack, seven SBDs were shot down when they flew unwittingly into the midst of the air raid and seventeen were destroyed on the ground. SBDs did shoot down two Japanese aircraft during the attack and, three days later, a Dauntless sank the Japanese submarine I-70 – the first enemy warship sunk by US Navy aircraft in the Second World War.

The SBD distinguished itself in subsequent combat, sinking a small Japanese carrier and severely damaging a heavy carrier in the May 1942 Battle of the Coral Sea, and a month later, in the epic Battle of Midway, SBDs helped destroy four Japanese carriers. The Dauntless played a role in the struggle against Hitler's Germany as well, patrolling the Atlantic against German U-boats and Vichy French shipping. New Zealand and the Free French Air Force also used the SBD in combat, and the A-24 flew with the Mexican Air Force.

In October 1942, deliveries began on the SBD-4s, virtually identical to the SBD-3 except for a new electrical system and the deletion of the propeller spinner. Over 3,000 SBD-5s were built, the most numerous Dauntless variant. When production of the legendary aircraft ended in July 1944, 5,936 SBDs and A-24s had been manufactured.

The SBD was credited with sinking eighteen enemy warships and shooting down 138 Japanese aircraft, suffering fewer than a hundred lost to enemy fire – the lowest loss rate of any aircraft of the Second World War. Phased out of carrier operations by July 1944, the SBD continued service with the Marines on land bases until the war's end. With that, the Dauntless shares with the Grumman Wildcat the distinction of being the only two aircraft to serve the US Navy from 7 December 1941 to the Japanese surrender on 2 September 1945.

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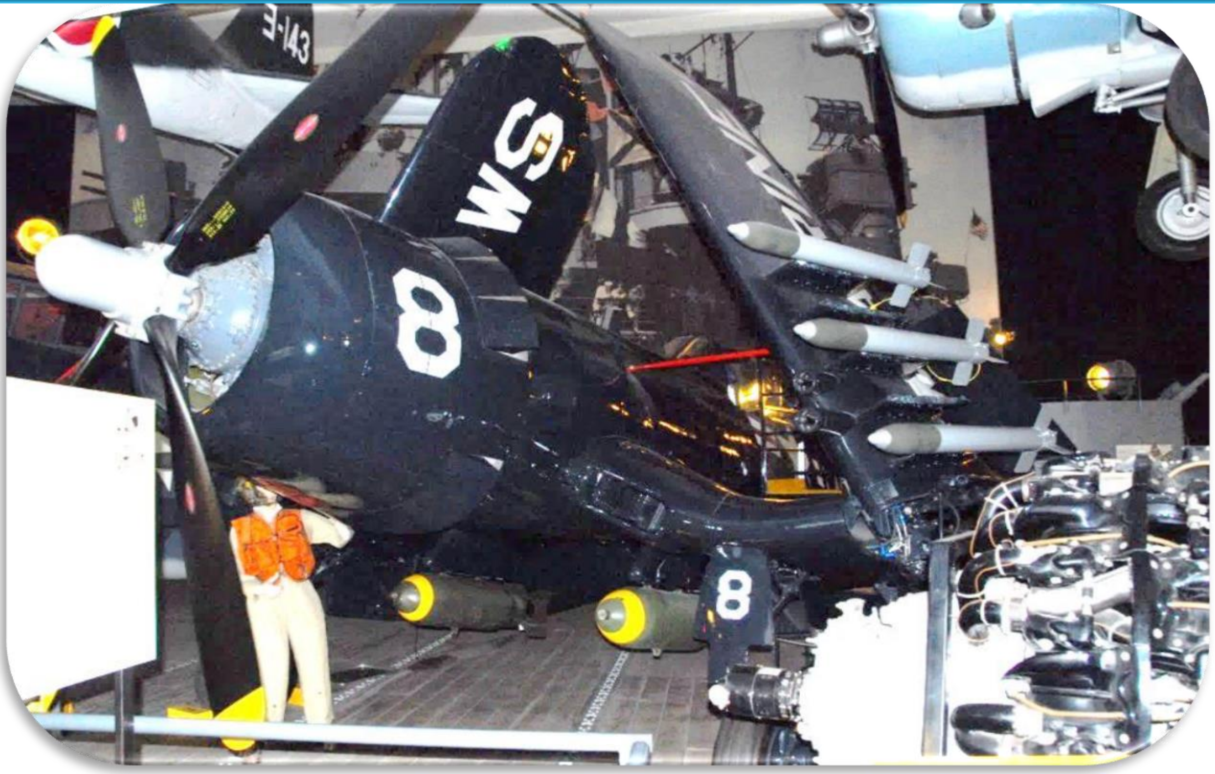

1st flight: 1940
(12,000+ built)

Key Points:

Vought F4U-7 Corsair (Original) 1940. Known as “Bent Wing Widow Maker” & “Whistling Death” Vs “Finest prop-driven fighter plane ever”. **Designed for carriers, bulk flown by Marines from Central Pacific islands, Philippines, & Okinawa**. Amassed a **kill ratio of 11:1**. Faster than most Navy fighters, more than **12,000 built**. Used for **fighter & low level ground attack in Korea**. In 1955, Corsair’s still active with U.S. Marines and French Navy, saw action until 1964.
This: In the markings of San Diego Padres announcer **Jerry Coleman**, who flew SBDs in WW II & F4Us in Korea. Built in 1945, delivered to French, 1953, saw service in Algeria and Suez. Back in US in 1964, severely damaged in **Hurricane Katrina** and returned to the Naval Museum. SDASM received in 2008, and restored it over a three year period.

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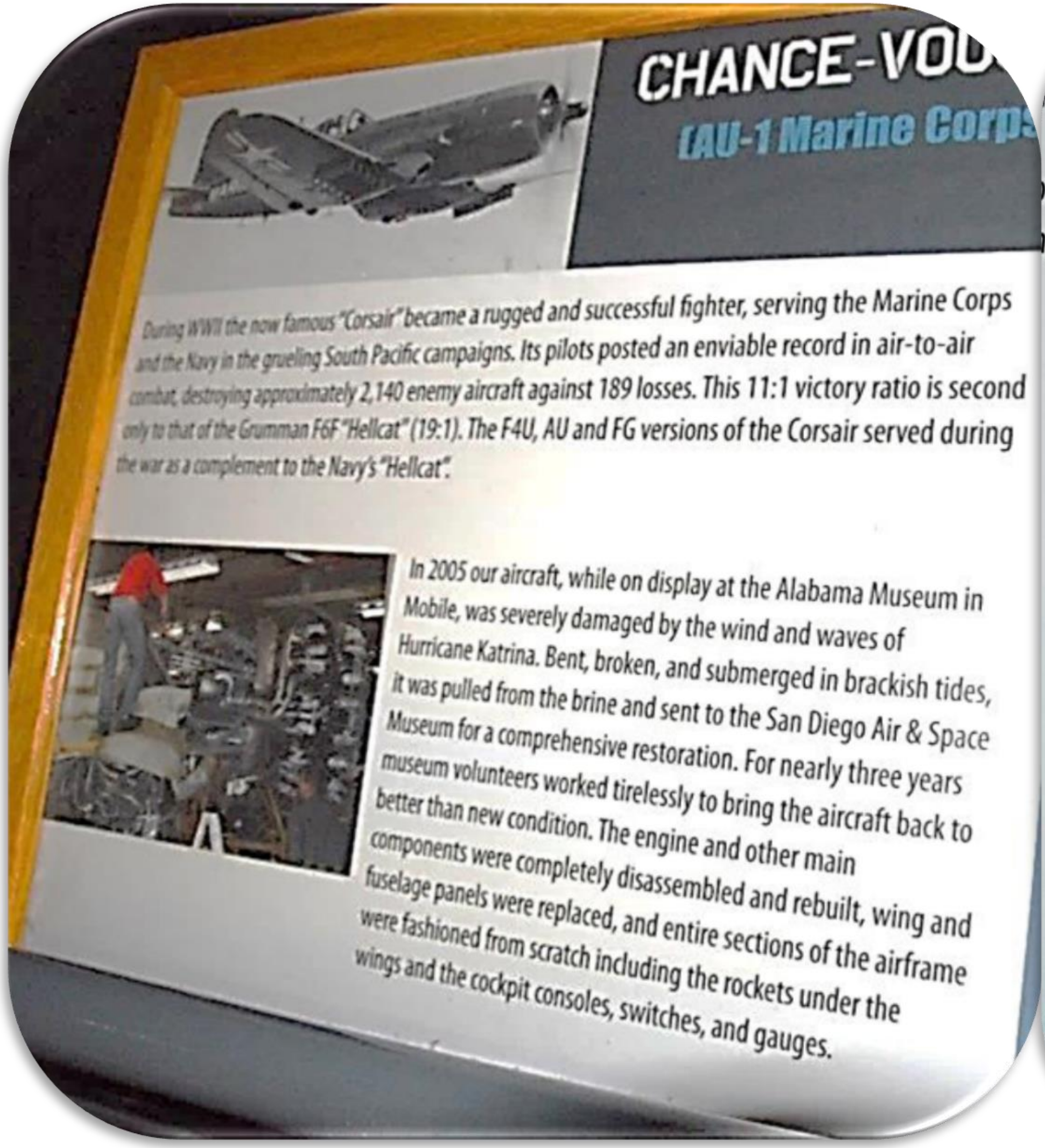
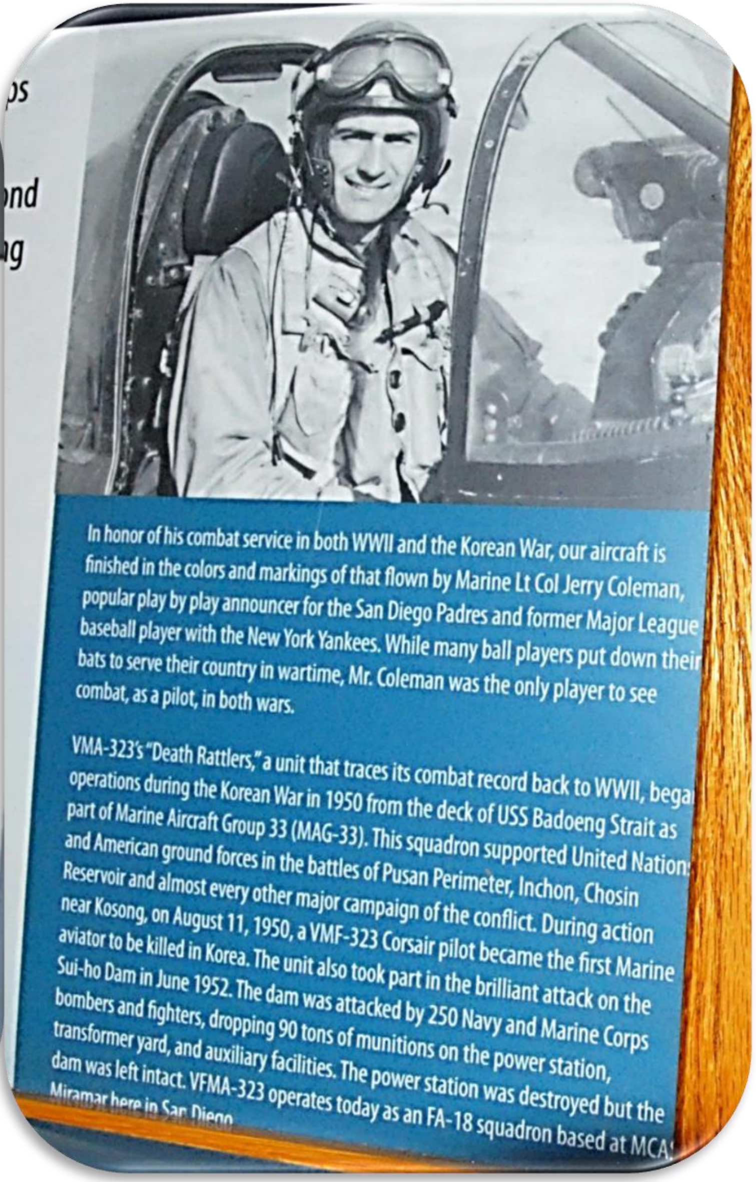


CHANCE-VOU

(AU-1 Marine Corps

During WWII the now famous "Corsair" became a rugged and successful fighter, serving the Marine Corps and the Navy in the grueling South Pacific campaigns. Its pilots posted an enviable record in air-to-air combat, destroying approximately 2,140 enemy aircraft against 189 losses. This 11:1 victory ratio is second only to that of the Grumman F6F "Hellcat" (19:1). The F4U, AU and FG versions of the Corsair served during the war as a complement to the Navy's "Hellcat".

In 2005 our aircraft, while on display at the Alabama Museum in Mobile, was severely damaged by the wind and waves of Hurricane Katrina. Bent, broken, and submerged in brackish tides, it was pulled from the brine and sent to the San Diego Air & Space Museum for a comprehensive restoration. For nearly three years museum volunteers worked tirelessly to bring the aircraft back to better than new condition. The engine and other main components were completely disassembled and rebuilt, wing and fuselage panels were replaced, and entire sections of the airframe were fashioned from scratch including the rockets under the wings and the cockpit consoles, switches, and gauges.



In honor of his combat service in both WWII and the Korean War, our aircraft is finished in the colors and markings of that flown by Marine Lt Col Jerry Coleman, popular play by play announcer for the San Diego Padres and former Major League baseball player with the New York Yankees. While many ball players put down their bats to serve their country in wartime, Mr. Coleman was the only player to see combat, as a pilot, in both wars.

VMA-323's "Death Rattlers," a unit that traces its combat record back to WWII, bega operations during the Korean War in 1950 from the deck of USS Badoeng Strait as part of Marine Aircraft Group 33 (MAG-33). This squadron supported United Nation and American ground forces in the battles of Pusan Perimeter, Inchon, Chosin Reservoir and almost every other major campaign of the conflict. During action near Kosong, on August 11, 1950, a VMF-323 Corsair pilot became the first Marine aviator to be killed in Korea. The unit also took part in the brilliant attack on the Sui-ho Dam in June 1952. The dam was attacked by 250 Navy and Marine Corps bombers and fighters, dropping 90 tons of munitions on the power station, transformer yard, and auxiliary facilities. The power station was destroyed but the dam was left intact. VFMA-323 operates today as an FA-18 squadron based at MCA Miramar here in San Diego.

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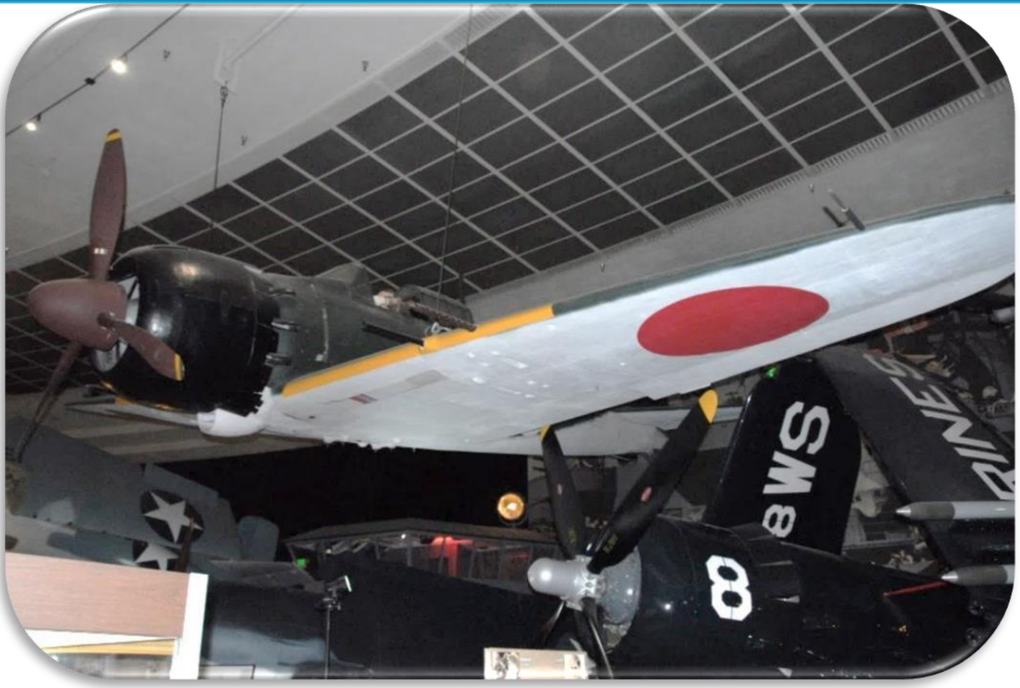

1st flight: 1939
(10,449 built)

Key Points:

Mitsubishi A6M7 Zero-sen (Original). Carrier fighter for Imperial Japanese Navy Air Service (IJNAS), from 1940 to 1945. Most famous and widely used aircraft in Japanese history. Universally known as "**Zero**", in Japan, "Rei-sen" & "Zero-sen;" Allied code name was "**Zeke**". Capable of **speeds over 300 miles per hour**, yet low landing speed suitable for carriers. All design and construction emphasized lightness, simplicity and utility. Very maneuverable, obtained a **6:1 kill ratio** over US F4F-U Wildcats early in WWII. Main drawbacks; lack of armor and heavy control forces at high speeds. Entered service **July, 1940**. A total of **10,449 were built**. Late in WWII, **most converted to Kamikaze planes**.

This: Built in **1945**, probably used in Home Defense of Japan late in the war. 12,000 hours to restore, on loan from Smithsonian since April 1984.

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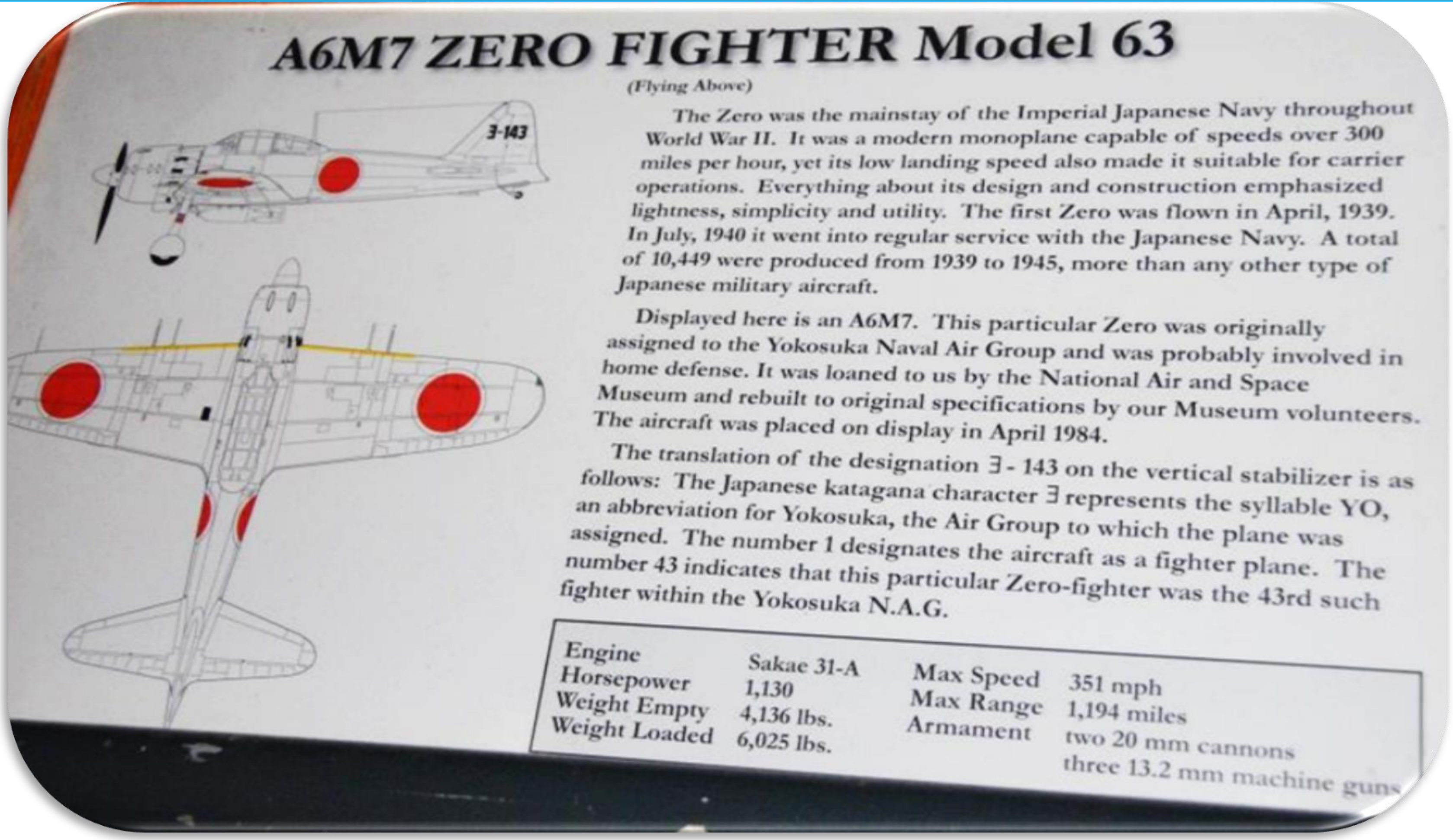

A6M7 ZERO FIGHTER Model 63

(Flying Above)

The Zero was the mainstay of the Imperial Japanese Navy throughout World War II. It was a modern monoplane capable of speeds over 300 miles per hour, yet its low landing speed also made it suitable for carrier operations. Everything about its design and construction emphasized lightness, simplicity and utility. The first Zero was flown in April, 1939. In July, 1940 it went into regular service with the Japanese Navy. A total of 10,449 were produced from 1939 to 1945, more than any other type of Japanese military aircraft.

Displayed here is an A6M7. This particular Zero was originally assigned to the Yokosuka Naval Air Group and was probably involved in home defense. It was loaned to us by the National Air and Space Museum and rebuilt to original specifications by our Museum volunteers. The aircraft was placed on display in April 1984.

The translation of the designation ヨ-143 on the vertical stabilizer is as follows: The Japanese katagana character ヨ represents the syllable YO, an abbreviation for Yokosuka, the Air Group to which the plane was assigned. The number 1 designates the aircraft as a fighter plane. The number 43 indicates that this particular Zero-fighter was the 43rd such fighter within the Yokosuka N.A.G.

Engine	Sakae 31-A	Max Speed	351 mph
Horsepower	1,130	Max Range	1,194 miles
Weight Empty	4,136 lbs.	Armament	two 20 mm cannons three 13.2 mm machine guns
Weight Loaded	6,025 lbs.		

Historical note: A damaged Zero was recovered on the Aleutian Islands (Jun 1942) and brought to San Diego's North Island for repairs. The fighter was reconstructed to gain a better understanding of enemy fighter capabilities such as climb rates, armor, speed, and range. Once the Zero was flyable it was painted with American markings and flown over San Diego several times while testing its flight capabilities and weaknesses.

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World War II Gallery

1st flight: 1942
(12,275 built)

Key Points:

Grumman F6F-3 Hellcat (Original). Descended from F4F Wildcat, but new design, **1st flight Jun 1942**. Carrier & land-based. **Countered A6M Zero;** more **maneuverable, good visibility, excellent armor, faster, higher climb rate, six 50 cal guns, 5,000+ victories;** a **19:1 kill ratio**. Superior to Zero except rate of turn at low speed. Ground support role; 60,000+ rockets fired on land targets & shipping. Over **12,275 produced**. Logged 110,162 combat sorties. Flew over USS Missouri for Japan's surrender. **1st Blue Angel team, 1946, flew Hellcats**.

This: Built in 1944, it never flew in combat, used for testing at Patuxent River, MD & Moffet Field, CA test centers. Flown from Moffet Field to NAS Miramar, May 1979, was presented to Museum. Battle markings of a plane assigned to the USS Yorktown.

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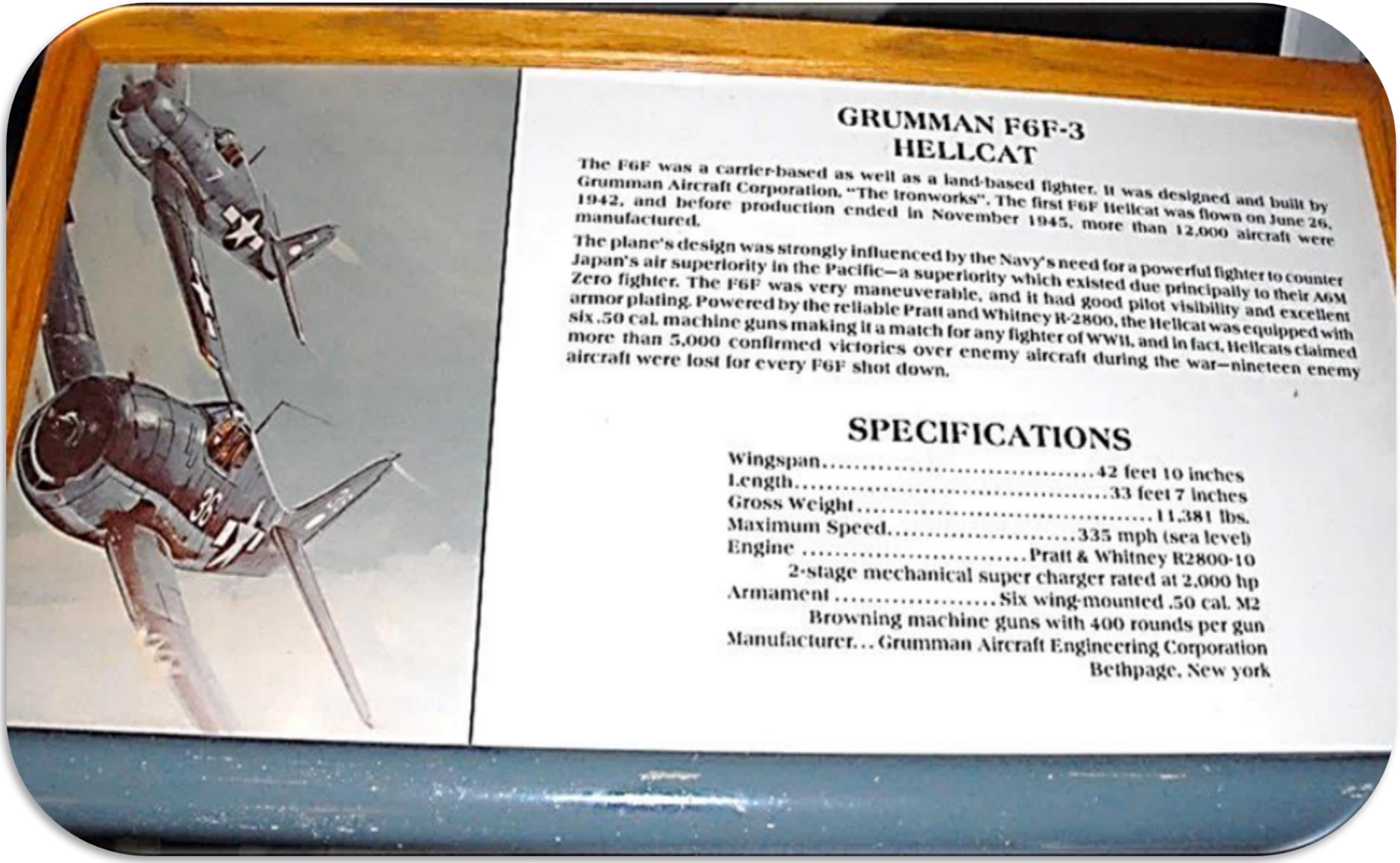
World War II Gallery



GRUMMAN F6F-3
HELLCAT

The F6F was a carrier-based as well as a land-based fighter. It was designed and built by Grumman Aircraft Corporation, "The Ironworks". The first F6F Hellcat was flown on June 26, 1942, and before production ended in November 1945, more than 12,000 aircraft were manufactured.

The plane's design was strongly influenced by the Navy's need for a powerful fighter to counter Japan's air superiority in the Pacific—a superiority which existed due principally to their A6M Zero fighter. The F6F was very maneuverable, and it had good pilot visibility and excellent armor plating. Powered by the reliable Pratt and Whitney R-2800, the Hellcat was equipped with six .50 cal. machine guns making it a match for any fighter of WWII, and in fact, Hellcats claimed more than 5,000 confirmed victories over enemy aircraft during the war—nineteen enemy aircraft were lost for every F6F shot down.

SPECIFICATIONS

Wingspan	42 feet 10 inches
Length	33 feet 7 inches
Gross Weight	11,381 lbs.
Maximum Speed	335 mph (sea level)
Engine	Pratt & Whitney R2800-10 2-stage mechanical super charger rated at 2,000 hp
Armament	Six wing-mounted .50 cal. M2 Browning machine guns with 400 rounds per gun
Manufacturer	Grumman Aircraft Engineering Corporation Bethpage, New york

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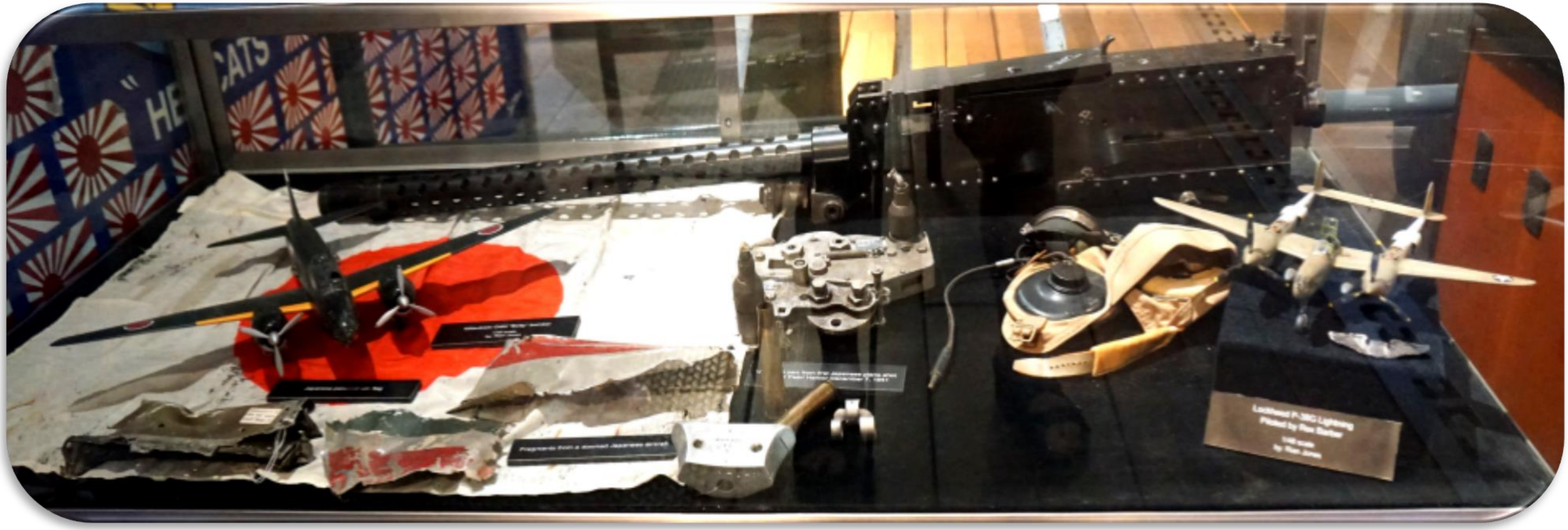

Intercepting Yamamoto: “*Operation Vengeance*” was the American military operation to kill **Admiral Isoroku Yamamoto** of the Imperial Japanese Navy on April 18, **1943**, during the Solomon Islands campaign, WW II. Yamamoto, **Commander of the Combined Fleet of the Imperial Japanese Navy**, was killed on **Bougainville Island** when his transport ”Betty” bomber aircraft was shot down by U.S. **Army Air Forces P-38 fighter aircraft** operating from **Henderson Field on Guadalcanal**.

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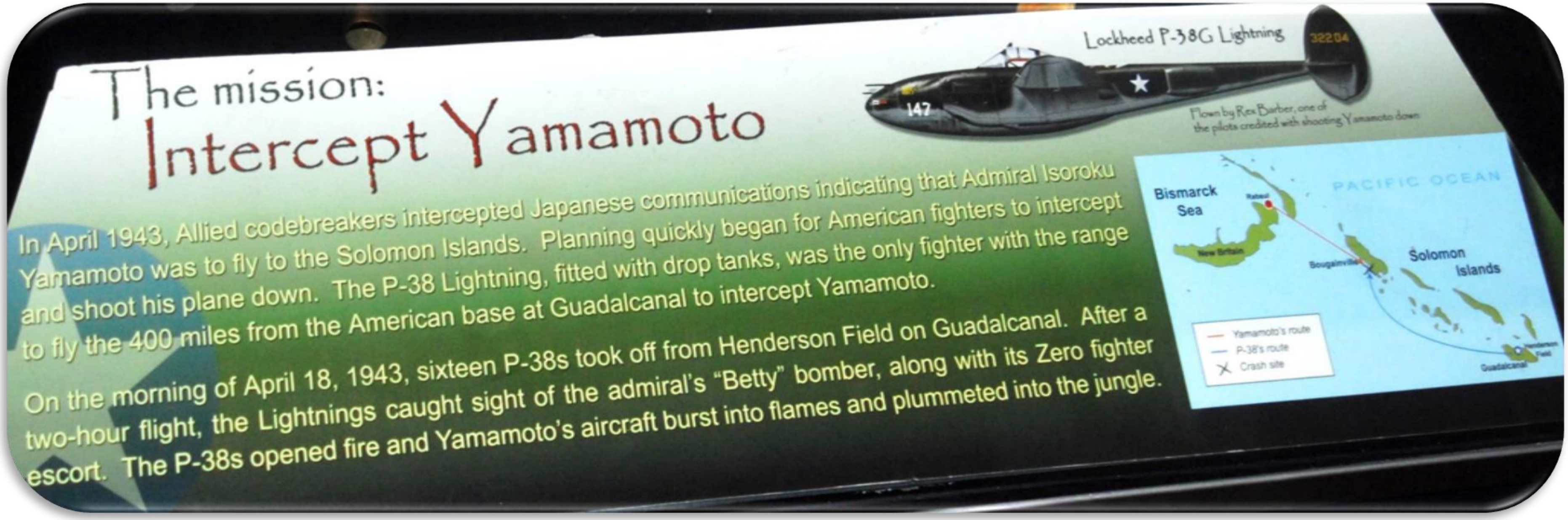
World War II Gallery



The mission: Intercept Yamamoto

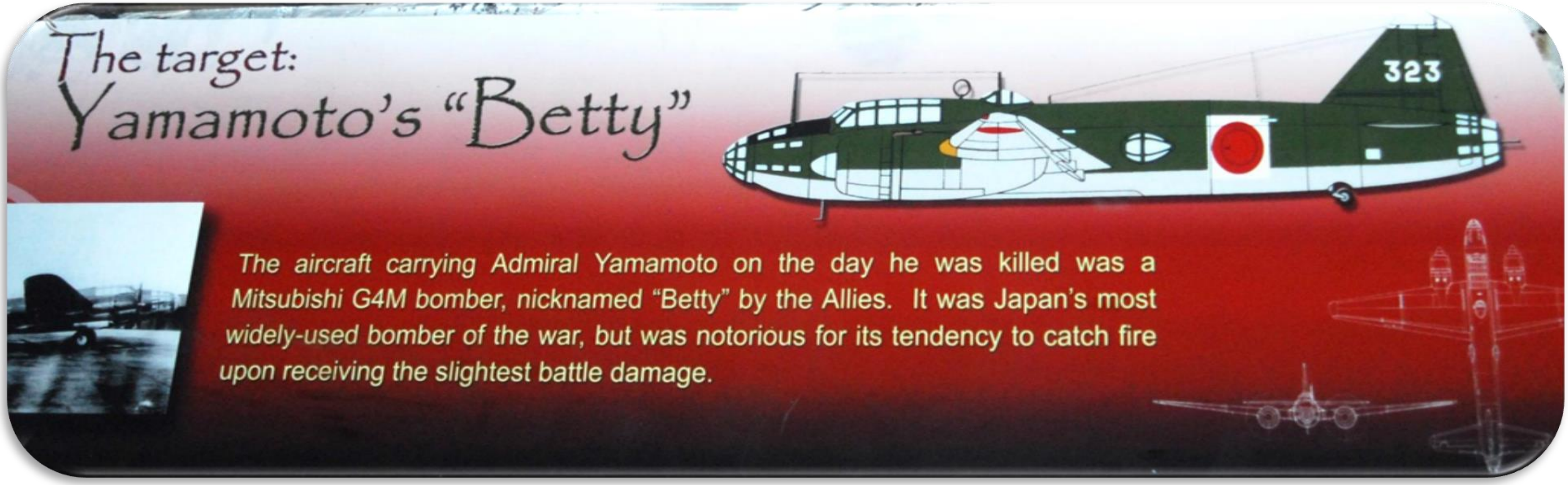
In April 1943, Allied codebreakers intercepted Japanese communications indicating that Admiral Isoroku Yamamoto was to fly to the Solomon Islands. Planning quickly began for American fighters to intercept and shoot his plane down. The P-38 Lightning, fitted with drop tanks, was the only fighter with the range to fly the 400 miles from the American base at Guadalcanal to intercept Yamamoto.

On the morning of April 18, 1943, sixteen P-38s took off from Henderson Field on Guadalcanal. After a two-hour flight, the Lightnings caught sight of the admiral's "Betty" bomber, along with its Zero fighter escort. The P-38s opened fire and Yamamoto's aircraft burst into flames and plummeted into the jungle.

Lockheed P-38G Lightning

Flown by Rex Barber, one of the pilots credited with shooting Yamamoto down

147
32204
Bismarck Sea
Rabaul
New Britain
PACIFIC OCEAN
Bougainville
Solomon Islands
Henderson Field
Guadalcanal
— Yamamoto's route
— P-38's route
✕ Crash site



The target: Yamamoto's "Betty"

The aircraft carrying Admiral Yamamoto on the day he was killed was a Mitsubishi G4M bomber, nicknamed "Betty" by the Allies. It was Japan's most widely-used bomber of the war, but was notorious for its tendency to catch fire upon receiving the slightest battle damage.

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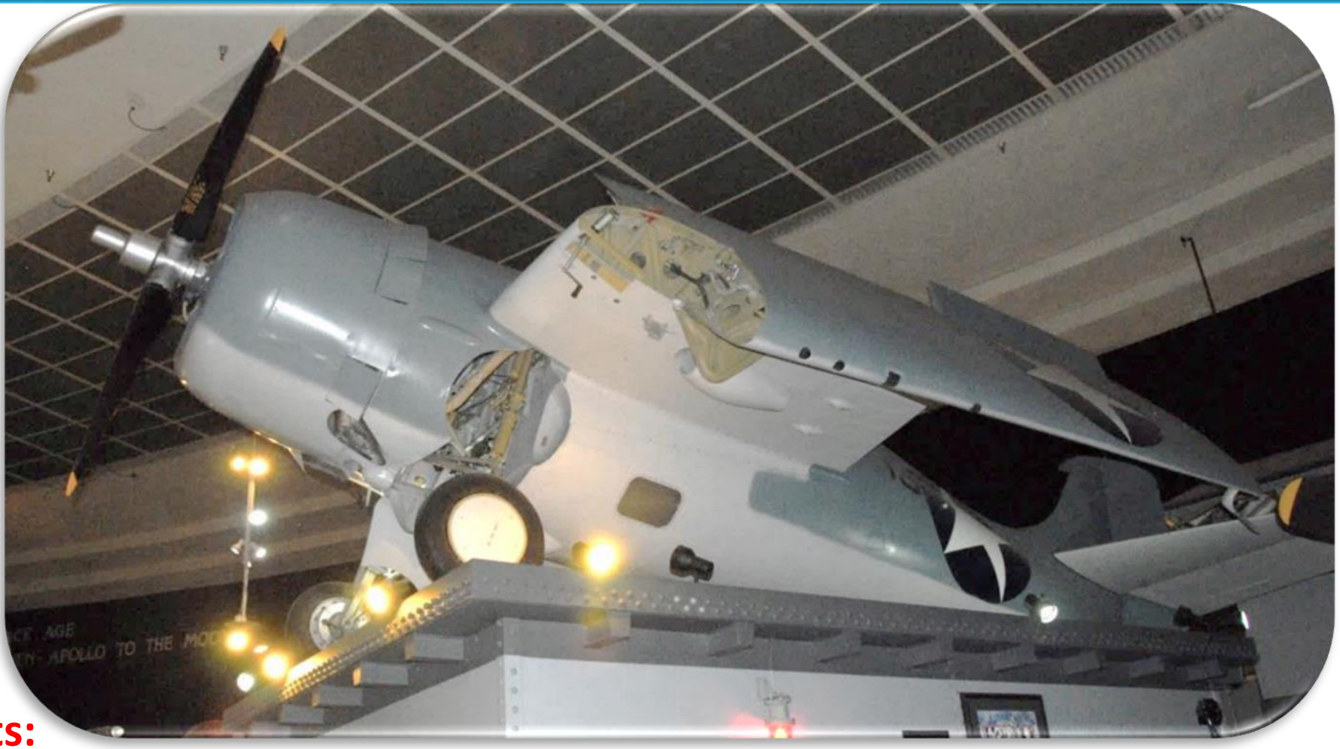
World War II Gallery



1st flight: 1940 (7,885 built)

Key Points:

Grumman F4F-4 Wildcat (Original). The **first of Grumman's "Cats"; designed in 1935; fleet 1940**. **Only carrier-based fighter at start of WW II**. Contemporary of the Zero, **performance was inferior (initially a 1:6 disadvantage to Zero)**, yet ultimately the F4F held its own due to **superior armament, rugged construction and well trained pilots**. Combat improvements: added 2 more 50 caliber mg's (total of six), self-sealing fuel tanks, armor, and **folding wings (first such feature)** for carriers ops. Limited maneuverability and range were mitigated by tactics that took advantage of speed and firepower, drop tanks improved range. Although F4F-4 replaced on carriers by Hellcats and Corsairs, it still had **over 1,500 victories**. **7,885 Wildcats produced.**

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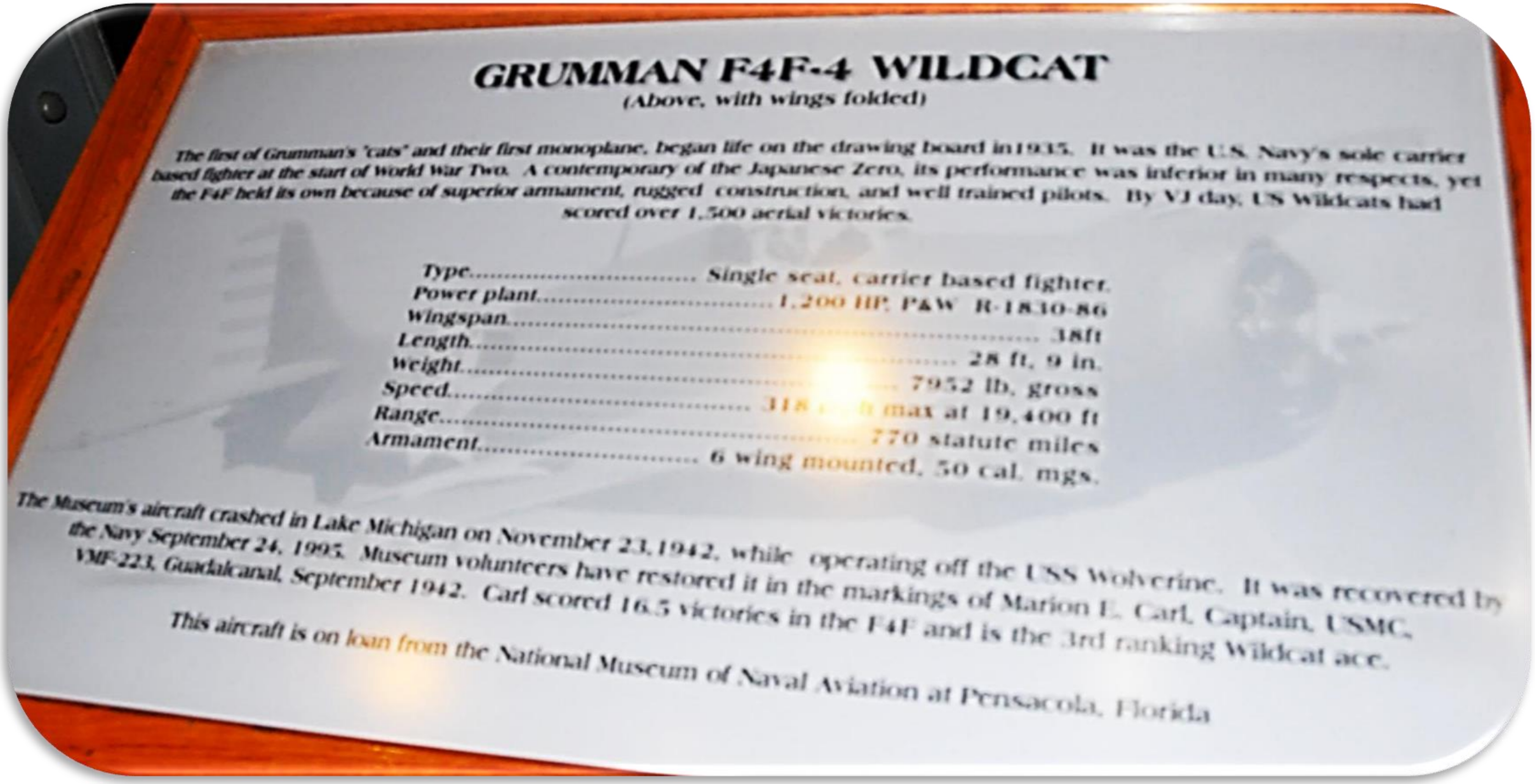

GRUMMAN F4F-4 WILDCAT

(Above, with wings folded)

The first of Grumman's "cats" and their first monoplane, began life on the drawing board in1935. It was the U.S. Navy's sole carrier *based fighter at the start of World War Two.* A contemporary of the Japanese Zero, its performance was inferior in many respects, yet *the F4F held its own because of superior armament, rugged* construction, and well trained pilots. By VJ day, US Wildcats had scored over 1,500 aerial victories.

Type.................................. Single seat, carrier based fighter.
Power plant.................................. 1,200 HP, P&W R-1830-86
Wingspan.. 38ft
Length.. 28 ft, 9 in.
Weight.. 7952 lb, gross
Speed.................................... 318 [illegible] max at 19,400 ft
Range.. 770 statute miles
Armament.................................. 6 wing mounted, 50 cal. mgs.

The Museum's aircraft crashed in Lake Michigan on November 23,1942, while operating off the USS Wolverine. It was recovered by *the Navy September 24, 1995.* Museum volunteers have restored it in the markings of Marion E. Carl, Captain, USMC, *VMF-223, Guadalcanal, September 1942.* Carl scored 16.5 victories in the F4F and is the 3rd ranking Wildcat ace.

This aircraft is on loan from the National Museum of Naval Aviation at Pensacola, Florida

This: **Grumman F4F-4 Wildcat (Original).** The Museum's F4F-4 Wildcat was attached to the USS Wolverine for carrier training when it crashed into **Lake Michigan** and sank on November 23, **1942**. Wreckage recovered by Navy in 1995, and loaned to the Museum in 1996 for restoration. Museum volunteers restored it in the markings of Marine Corps Squadron VMF-223, as the aircraft flown by **Captain Marion E. Carl**, 3rd ranking Wildcat ace with 16.5 victories. The aircraft is currently on loan from the National Museum of Naval Aviation at Pensacola, Florida.

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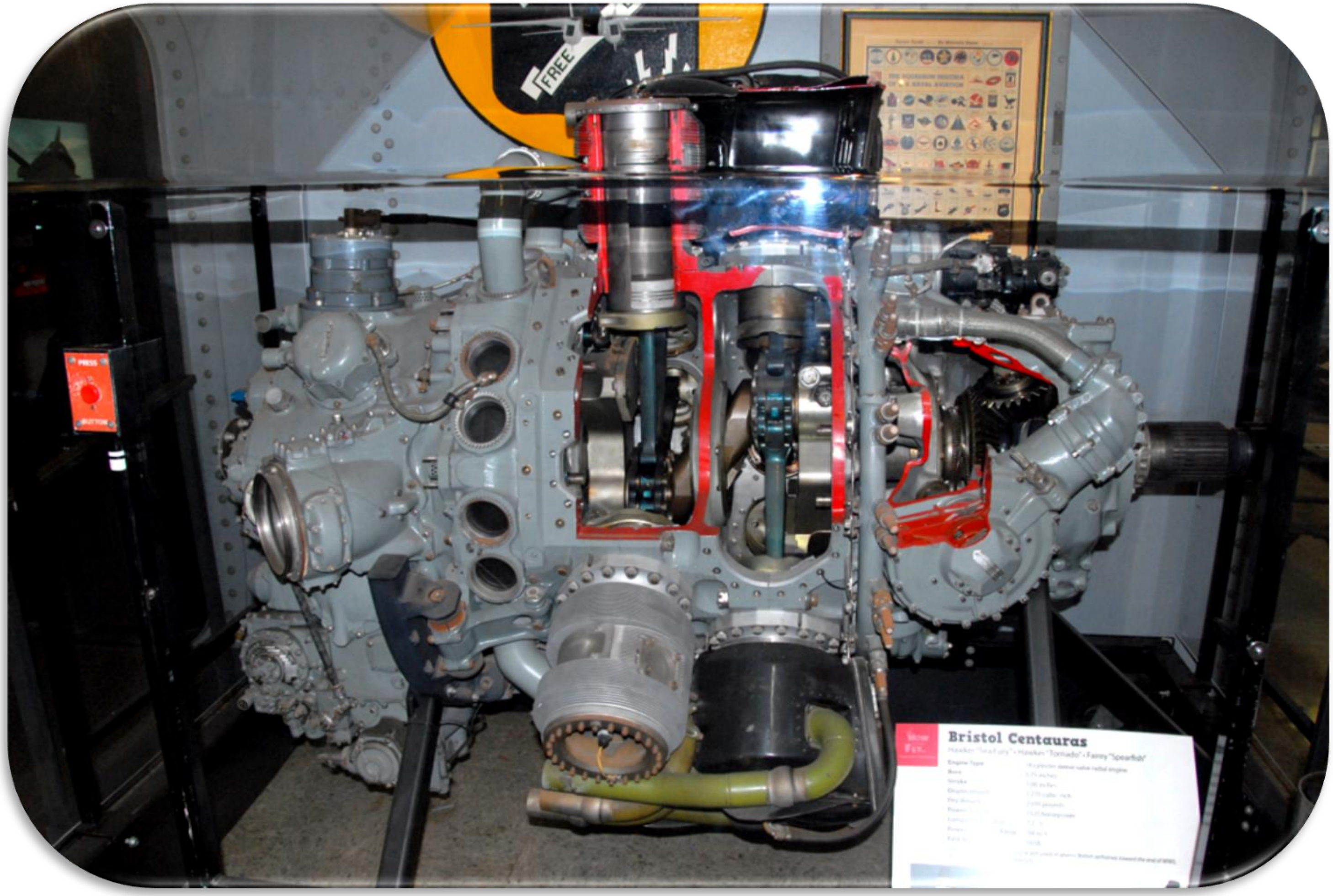
World War II Gallery



1st Run: 1938
(2,500+ built)

This: Bristol Centaurus (**Original**) was the final development of the Bristol Engine Company's series of **sleeve valve radial aircraft engines**. The Centaurus is an 18-cylinder, two-row design that eventually delivered over 3,000 hp. The engine was introduced into service late in the Second World War and was one of the most powerful aircraft piston engines to see service.

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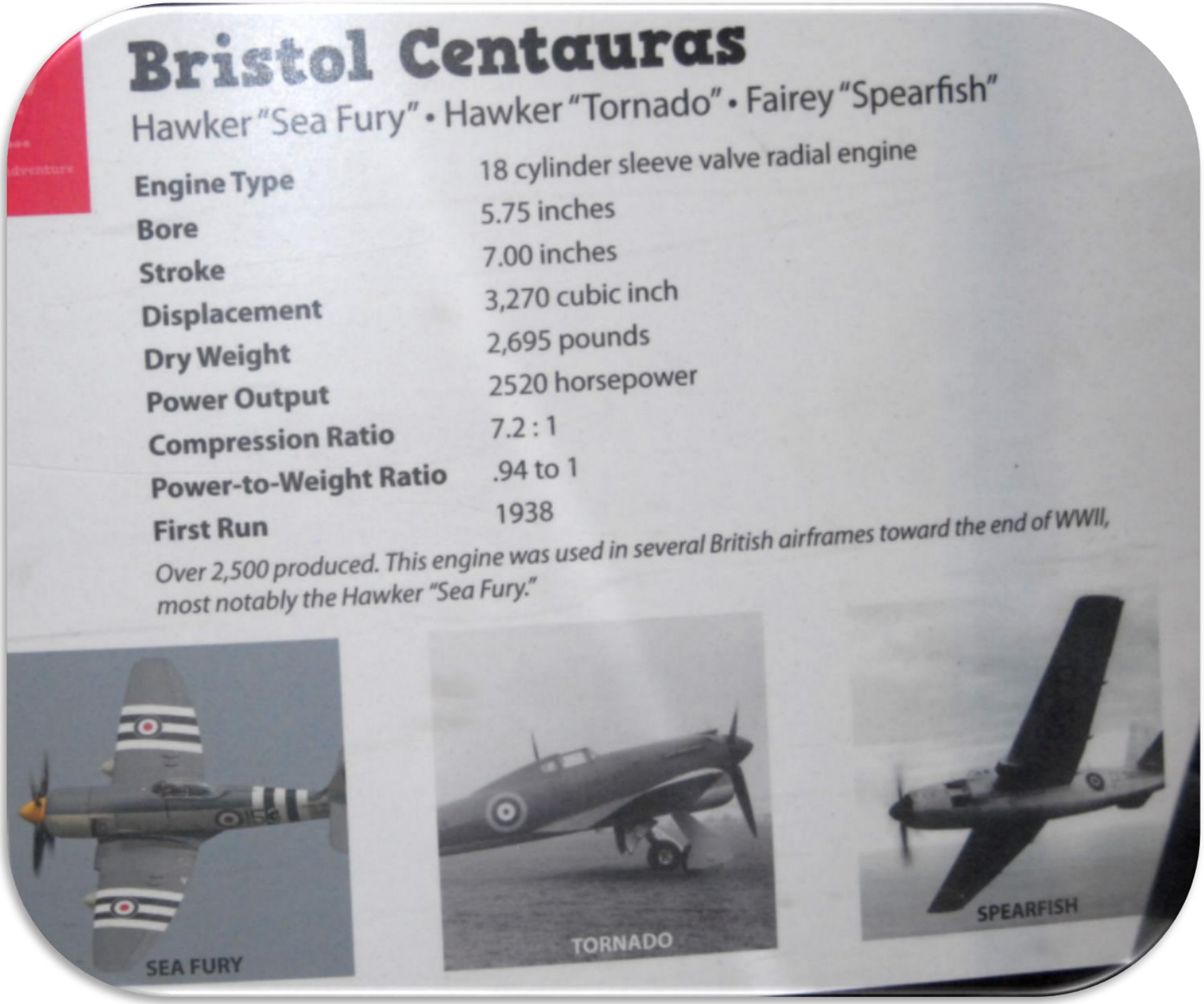

Bristol Centauras

Hawker "Sea Fury" • Hawker "Tornado" • Fairey "Spearfish"

Engine Type	18 cylinder sleeve valve radial engine
Bore	5.75 inches
Stroke	7.00 inches
Displacement	3,270 cubic inch
Dry Weight	2,695 pounds
Power Output	2520 horsepower
Compression Ratio	7.2 : 1
Power-to-Weight Ratio	.94 to 1
First Run	1938

Over 2,500 produced. This engine was used in several British airframes toward the end of WWII, most notably the Hawker "Sea Fury."

SEA FURY

TORNADO

SPEARFISH

Jet Age Gallery

Jet Age Gallery

KOREAN War

MIG ALLEY 200 MILES

Key Points: **The Korean War** (25 June **1950** – 27 July **1953**) was the **first war for newly formed U. S. Air Force**. **First time U.S. jet aircraft entered into battle**. Air Force **F-86 Sabre jets** bested Soviet-built MiG-15 fighters in aerial combat. World War II-era prop-driven **F-4U** Corsairs, **P-51D** Mustangs and **F-6F** drones were pressed into ground-air support role. **B-29** Superfortresses flew for the last time on bombing missions. Air Force primarily flew the **F-80** Shooting Star, **F-84** Thunderjet, and **F-86**, while the Navy flew the **F9F** Panther and **F2H** Banshee. Korea saw the **first large-scale use of helicopters**. The US suffered **4,055 service personnel killed and 2,714 aircraft lost** with the USAF suffering 1,841 battle casualties (1,180 were killed in action).

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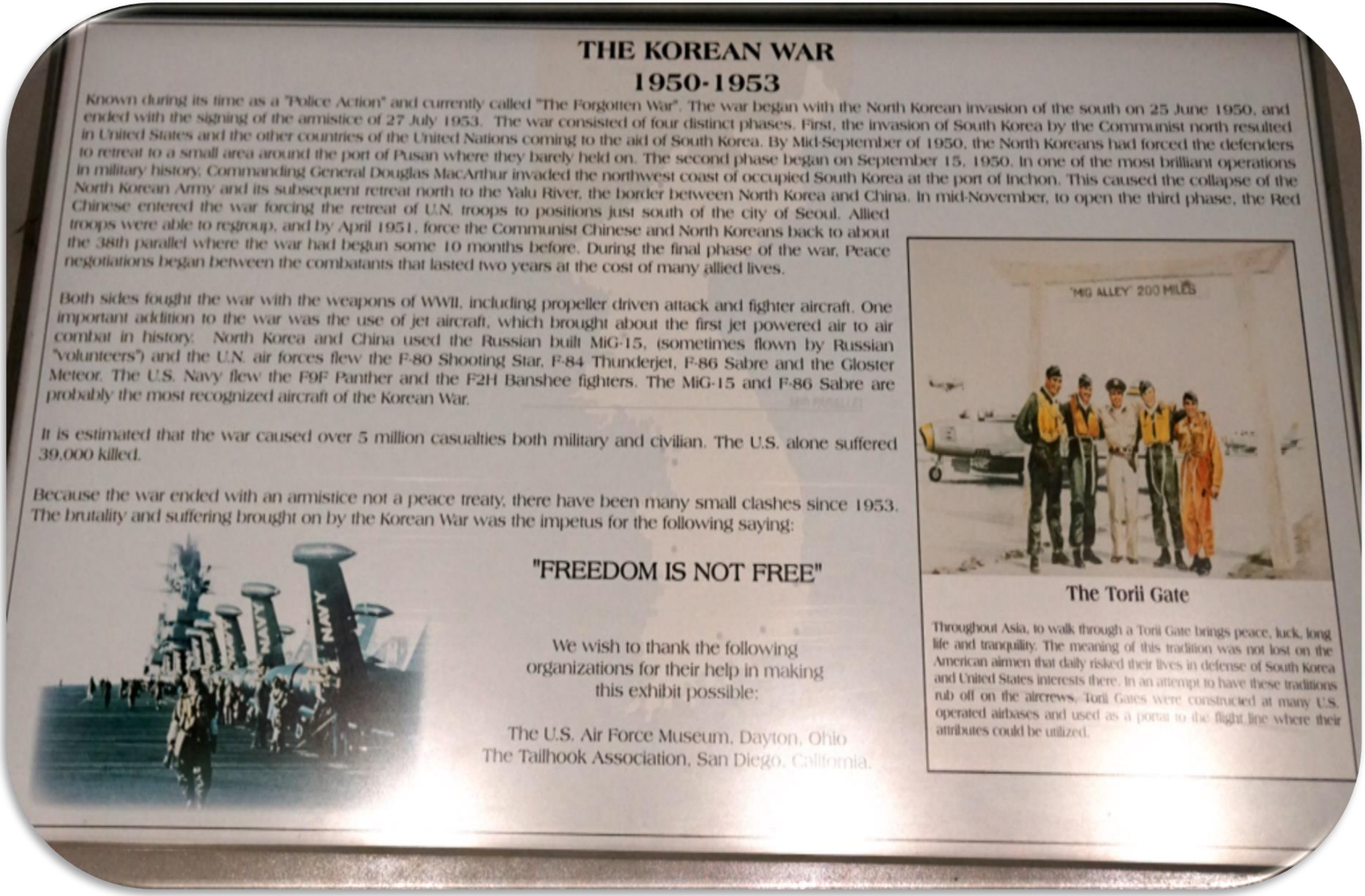


THE KOREAN WAR

1950-1953

Known during its time as a "Police Action" and currently called "The Forgotten War". The war began with the North Korean invasion of the south on 25 June 1950, and *ended with the signing of the armistice of* 27 July 1953. The war consisted of four distinct phases. First, the invasion of South Korea by the Communist north resulted *in United States and the other countries of the* United Nations coming to the aid of South Korea. By Mid-September of 1950, the North Koreans had forced the defenders *to retreat to a small area around the port of* Pusan where they barely held on. The second phase began on September 15, 1950. In one of the most brilliant operations *in military history.* Commanding General Douglas MacArthur invaded the northwest coast of occupied South Korea at the port of Inchon. This caused the collapse of the *North Korean Army and its subsequent retreat* north to the Yalu River, the border between North Korea and China. In mid-November, to open the third phase, the Red *Chinese entered the war forcing the retreat of* U.N. troops to positions just south of the city of Seoul. Allied *troops were able to regroup, and by April* 1951, force the Communist Chinese and North Koreans back to about *the 38th parallel where the war had* begun some 10 months before. During the final phase of the war, Peace *negotiations began between the* combatants that lasted two years at the cost of many allied lives.

Both sides fought the war with the weapons of WWII, including propeller driven attack and fighter aircraft. One important addition to the war was the use of jet aircraft, which brought about the first jet powered air to air combat in history. North Korea and China used the Russian built MiG-15, (sometimes flown by Russian "volunteers") and the U.N. air forces flew the F-80 Shooting Star, F-84 Thunderjet, F-86 Sabre and the Gloster Meteor. The U.S. Navy flew the F9F Panther and the F2H Banshee fighters. The MiG-15 and F-86 Sabre are probably the most recognized aircraft of the Korean War.

It is estimated that the war caused over 5 million casualties both military and civilian. The U.S. alone suffered 39,000 killed.

Because the war ended with an armistice not a peace treaty, there have been many small clashes since 1953. The brutality and suffering brought on by the Korean War was the impetus for the following saying:

"FREEDOM IS NOT FREE"

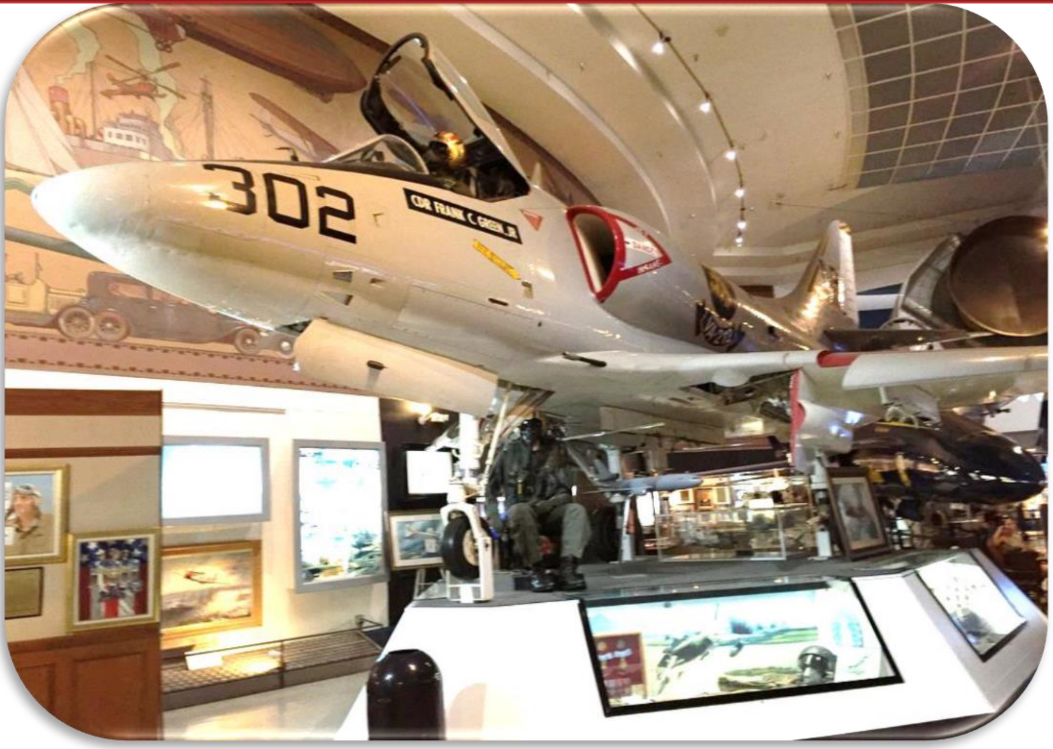
We wish to thank the following
organizations for their help in making
this exhibit possible:

The U.S. Air Force Museum, Dayton, Ohio
The Tailhook Association, San Diego, California

The Torii Gate

Throughout Asia, to walk through a Torii Gate brings peace, luck, long life and tranquility. The meaning of this tradition was not lost on the American airmen that daily risked their lives in defense of South Korea and United States interests there. In an attempt to have these traditions rub off on the aircrews, Torii Gates were constructed at many U.S. operated airbases and used as a portal to the flight line where their attributes could be utilized.

Jet Age Gallery



1st flight: 1954
(2960 built)

Key Points:

Douglas A-4B Skyhawk (Original). Designer Edward Heinemann; simple, no frills approach to combat aircraft: **small, light-weight, carrier-based attack bomber to deliver nuclear weapons**. Does not have folding wings. Simpler, lighter wing enabling **enormous weapons loads**. **1st flew on June 22, 1954**. Delivery to Navy/Marines in **Sep, 1956**. Midair refueling probe and could carry **330-gallon "buddy" refueling tank**. **Major combat role in Vietnam, Top Gun fighter school & Blue Angels. Total of 2960 built**.

This: Served with Attack Squadron 15 in 1960s. Markings of **CDR Frank Green, who was shot down and killed over North Vietnam in 1972**. On indefinite loan from the U.S. Navy.

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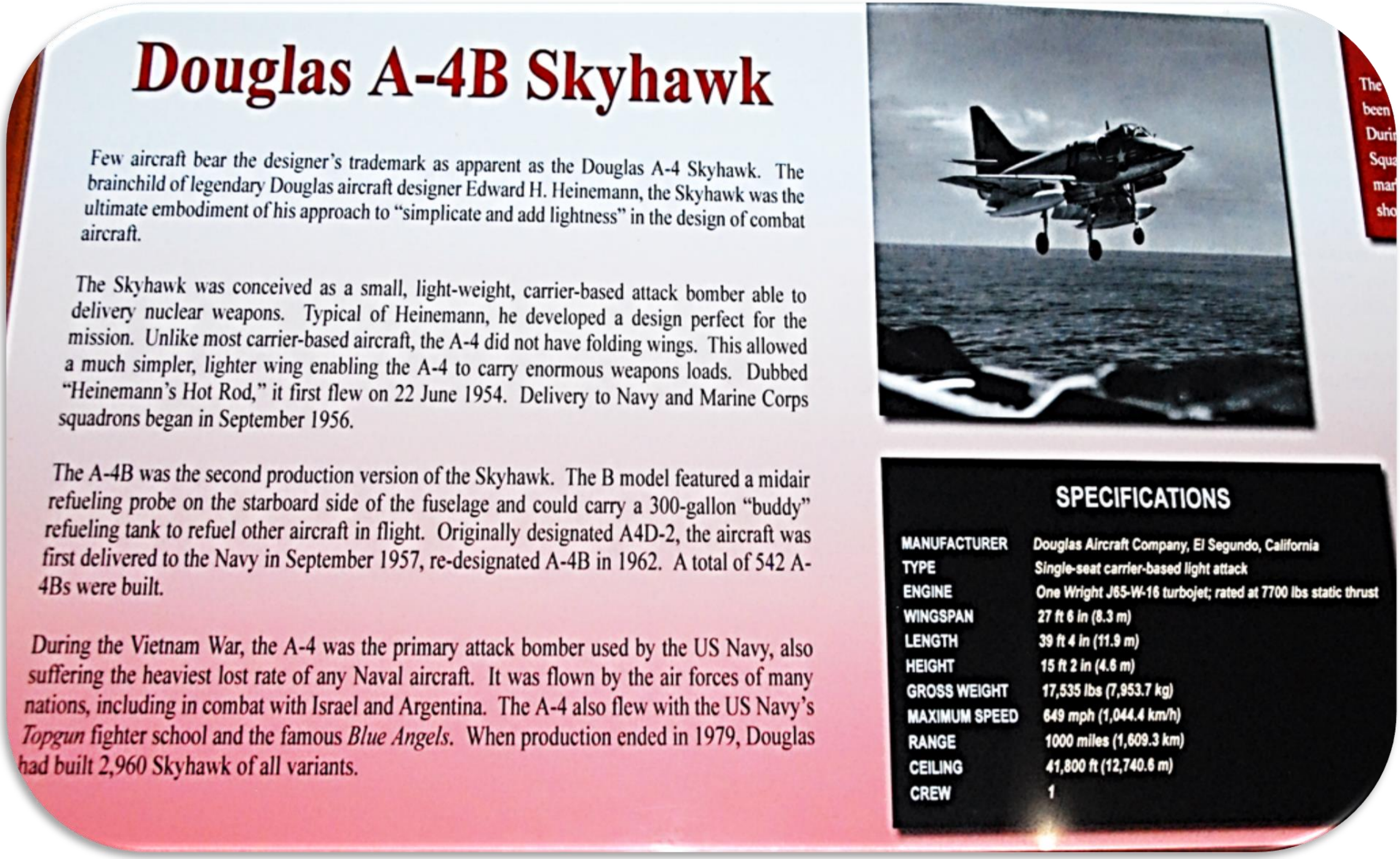

Douglas A-4B Skyhawk

Few aircraft bear the designer's trademark as apparent as the Douglas A-4 Skyhawk. The brainchild of legendary Douglas aircraft designer Edward H. Heinemann, the Skyhawk was the ultimate embodiment of his approach to "simplicate and add lightness" in the design of combat aircraft.

The Skyhawk was conceived as a small, light-weight, carrier-based attack bomber able to delivery nuclear weapons. Typical of Heinemann, he developed a design perfect for the mission. Unlike most carrier-based aircraft, the A-4 did not have folding wings. This allowed a much simpler, lighter wing enabling the A-4 to carry enormous weapons loads. Dubbed "Heinemann's Hot Rod," it first flew on 22 June 1954. Delivery to Navy and Marine Corps squadrons began in September 1956.

The A-4B was the second production version of the Skyhawk. The B model featured a midair refueling probe on the starboard side of the fuselage and could carry a 300-gallon "buddy" refueling tank to refuel other aircraft in flight. Originally designated A4D-2, the aircraft was first delivered to the Navy in September 1957, re-designated A-4B in 1962. A total of 542 A-4Bs were built.

During the Vietnam War, the A-4 was the primary attack bomber used by the US Navy, also suffering the heaviest lost rate of any Naval aircraft. It was flown by the air forces of many nations, including in combat with Israel and Argentina. The A-4 also flew with the US Navy's *Topgun* fighter school and the famous *Blue Angels*. When production ended in 1979, Douglas had built 2,960 Skyhawk of all variants.

SPECIFICATIONS

MANUFACTURER	*Douglas Aircraft Company, El Segundo, California*
TYPE	*Single-seat carrier-based light attack*
ENGINE	*One Wright J65-W-16 turbojet; rated at 7700 lbs static thrust*
WINGSPAN	*27 ft 6 in (8.3 m)*
LENGTH	*39 ft 4 in (11.9 m)*
HEIGHT	*15 ft 2 in (4.6 m)*
GROSS WEIGHT	*17,535 lbs (7,953.7 kg)*
MAXIMUM SPEED	*649 mph (1,044.4 km/h)*
RANGE	*1000 miles (1,609.3 km)*
CEILING	*41,800 ft (12,740.6 m)*
CREW	*1*

Jet Age Gallery

VIETNAM War

Key Points: **Vietnam War** (Nov 1, **1955** – Apr 30, **1975**), thousands of U.S. aircraft were lost to AAA, SAMs, MiGs and ground fire. More F-4 Phantoms and helicopters were lost than any other type in service with any nation. U.S. lost 528 F-4s and 5,607 helicopters. In total, the United States military lost in Vietnam almost 10,000 aircraft, helicopters and UAVs (3,744 planes, 5,607 helicopters and 578 UAVs).

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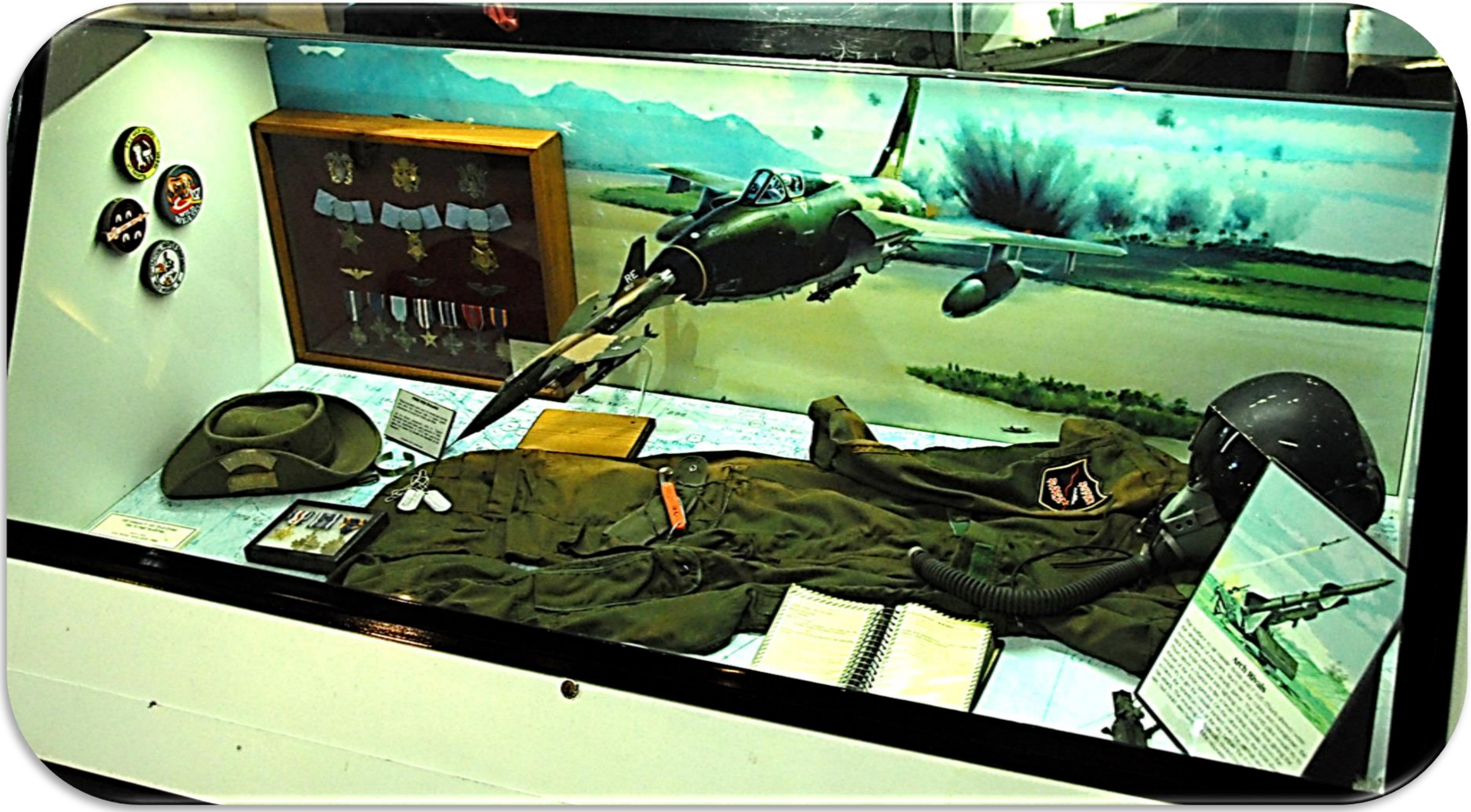
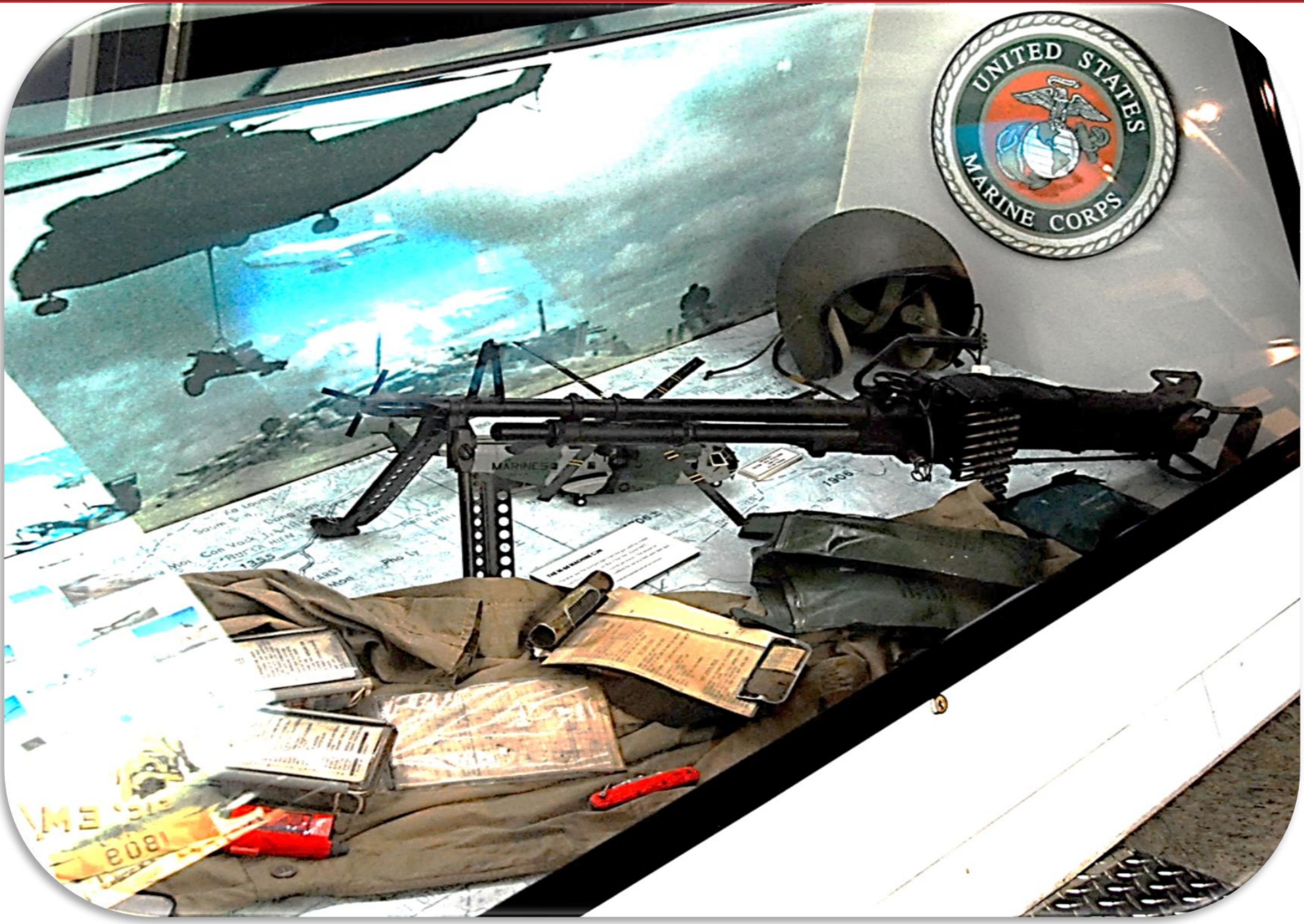


This: **US Air Force Vietnam** (**Original**) pilot memorabilia and examples of Air Force, Army and Navy/Marine Medals of Honor.

Jet Age Gallery



This: **US Marine Corps Vietnam** (**Original**) pilot memorabilia and M-60 machine gun.

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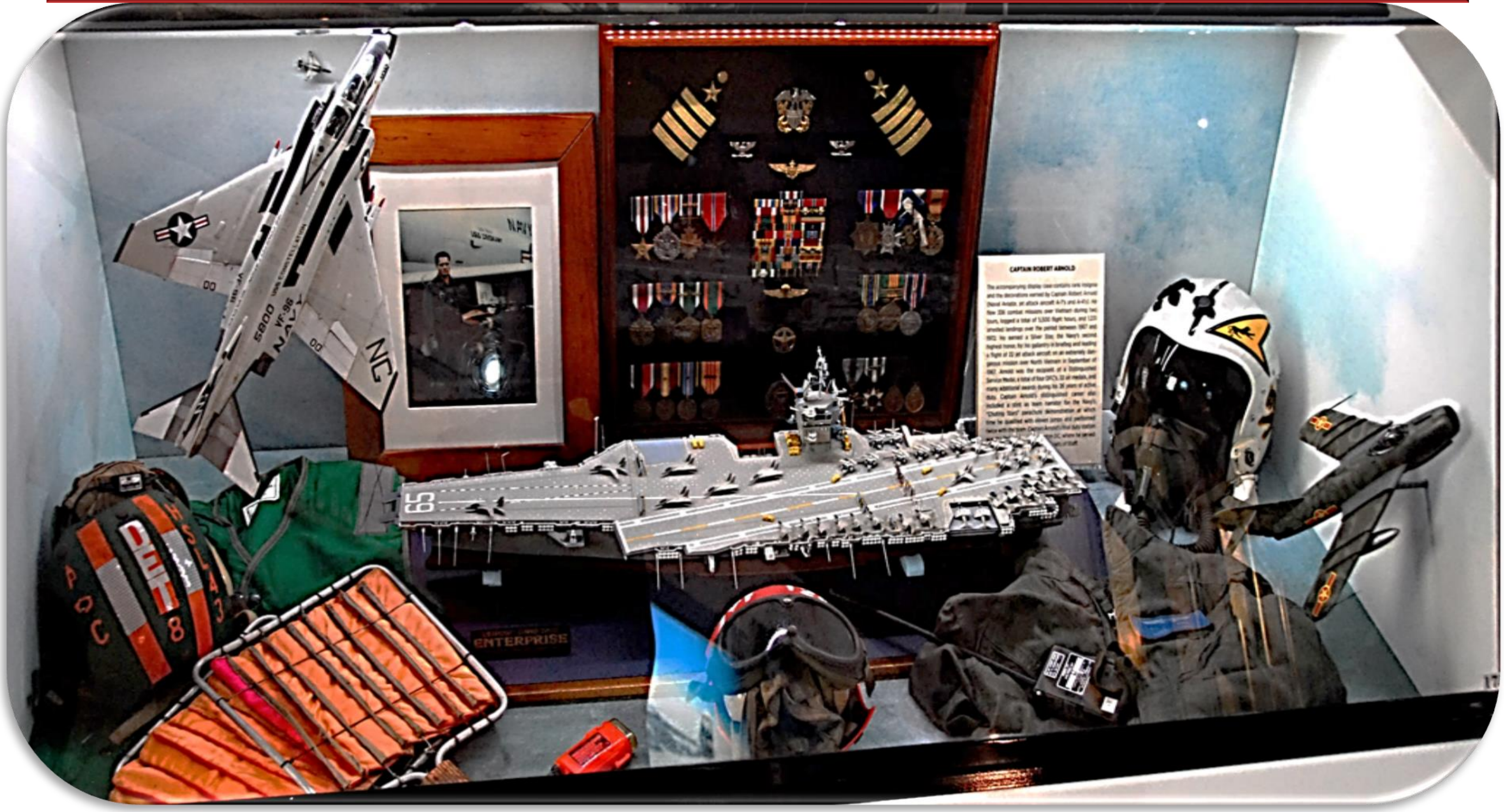

This: **US Navy Vietnam** (**Original**) pilot memorabilia. From the collection of Navy **Captain Robert Arnold**, who flew A-7's & A-4's during 336 combat missions over Vietnam during two tours. He received the Silver Star, 4 Distinguished Flying Crosses and 32 Air Medals, among others. Arnold has been interviewed by the SDASM Oral History Project and is laid to rest at the Miramar National Cemetery.

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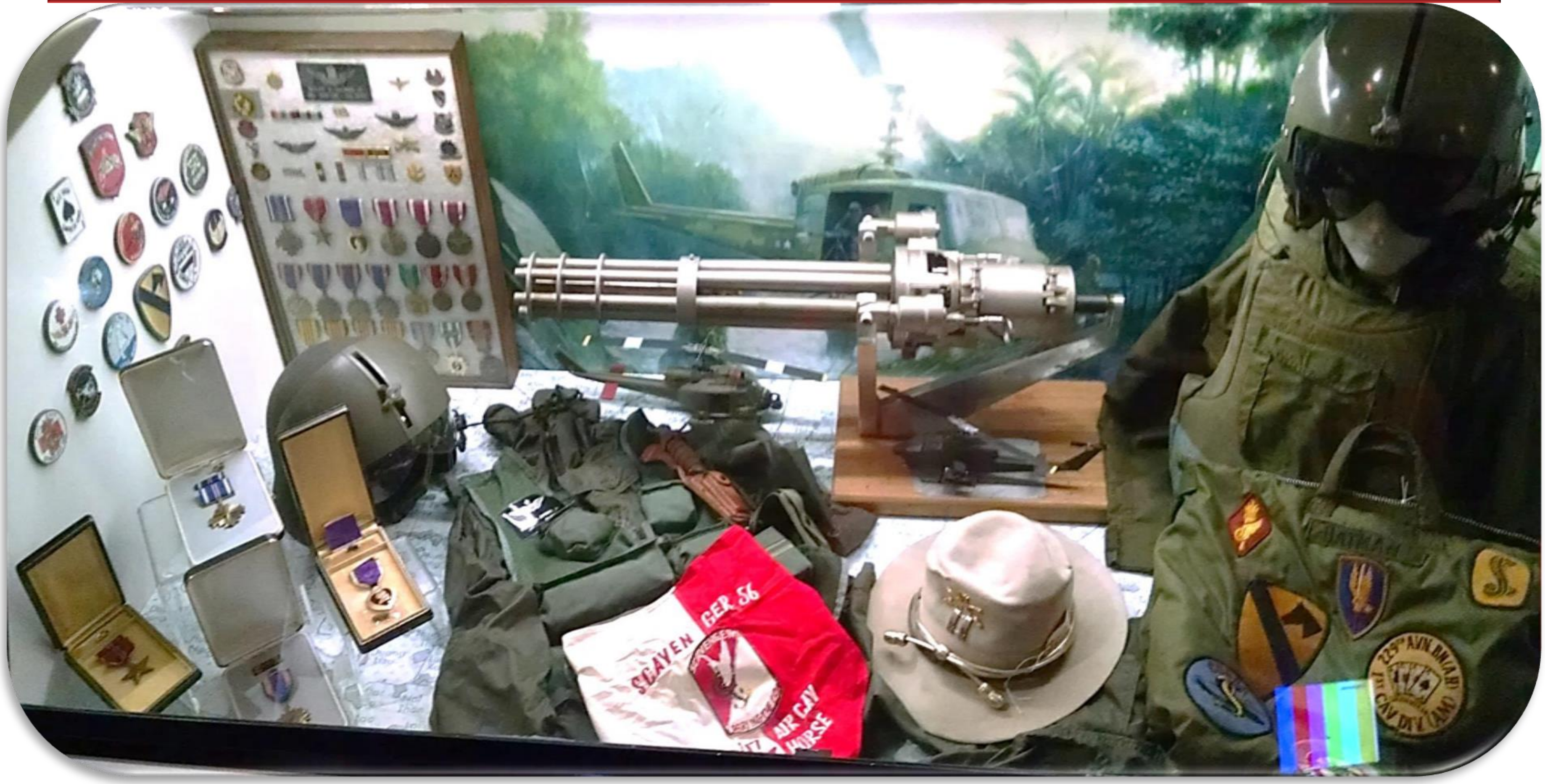

SCAVENGER 56
AIR CAV
HORSE
OATMAN
225th AVN BN(AH)
1st CAV DIV (AMO)

This: **US Army Vietnam** (**Original**) pilot memorabilia, from the collection of **Dudley Oatman**, SDASM Docent. 4 boxed medals: (top) Distinguished Flying Cross, Purple Heart, Air Medals and Bronze Star. **Note:** In the Purple Heart box is the **core of the bullet removed from Oatman's right arm.** Helmet, survival vest, Cav Hat, helmet bag worn/used in Vietnam, 1971/2. Also, an example of a 6,000 rounds per minute M-134 Minigun, used on AH-1 Cobra, UH-1 Huey, and OH-6 Gunships.

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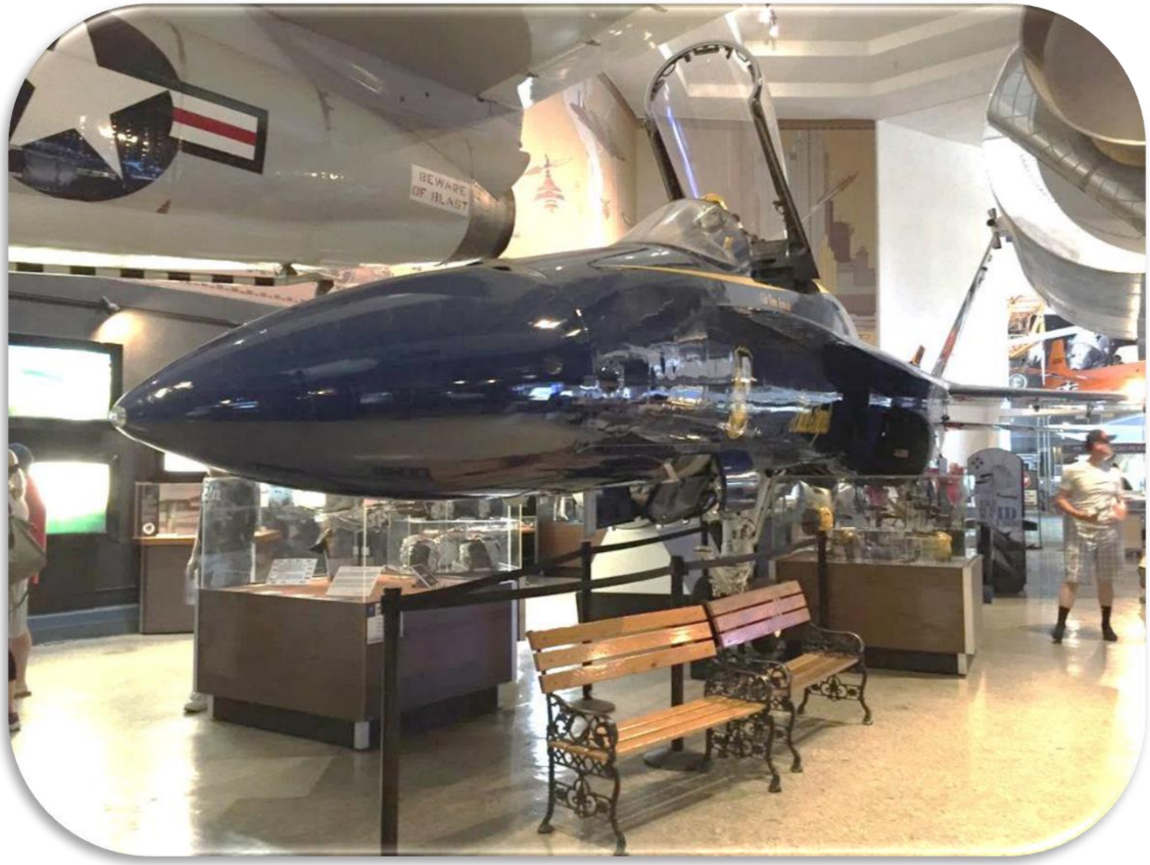

1st flight: 1978
(1480 built)

Key Points:

F/A-18A Hornet Blue Angel 1 **(Original)**. McDonnell Douglas (now Boeing). A **supersonic, all-weather carrier-capable multi-role fighter jet, attack ground and aerial targets;** first production; **1980**. A **replacement for the F-4 Phantom,** with **Blue Angels** since 1986, also replaced A-4 Skyhawk. **1480 built, still in active service**.

This: Built 1981, was flown by Blue Angels. Arrived in February 2009. **Commander Greg McWherter**, assumed command of the **Blue Angels** in November 2008. On loan from National Museum of Naval Aviation.

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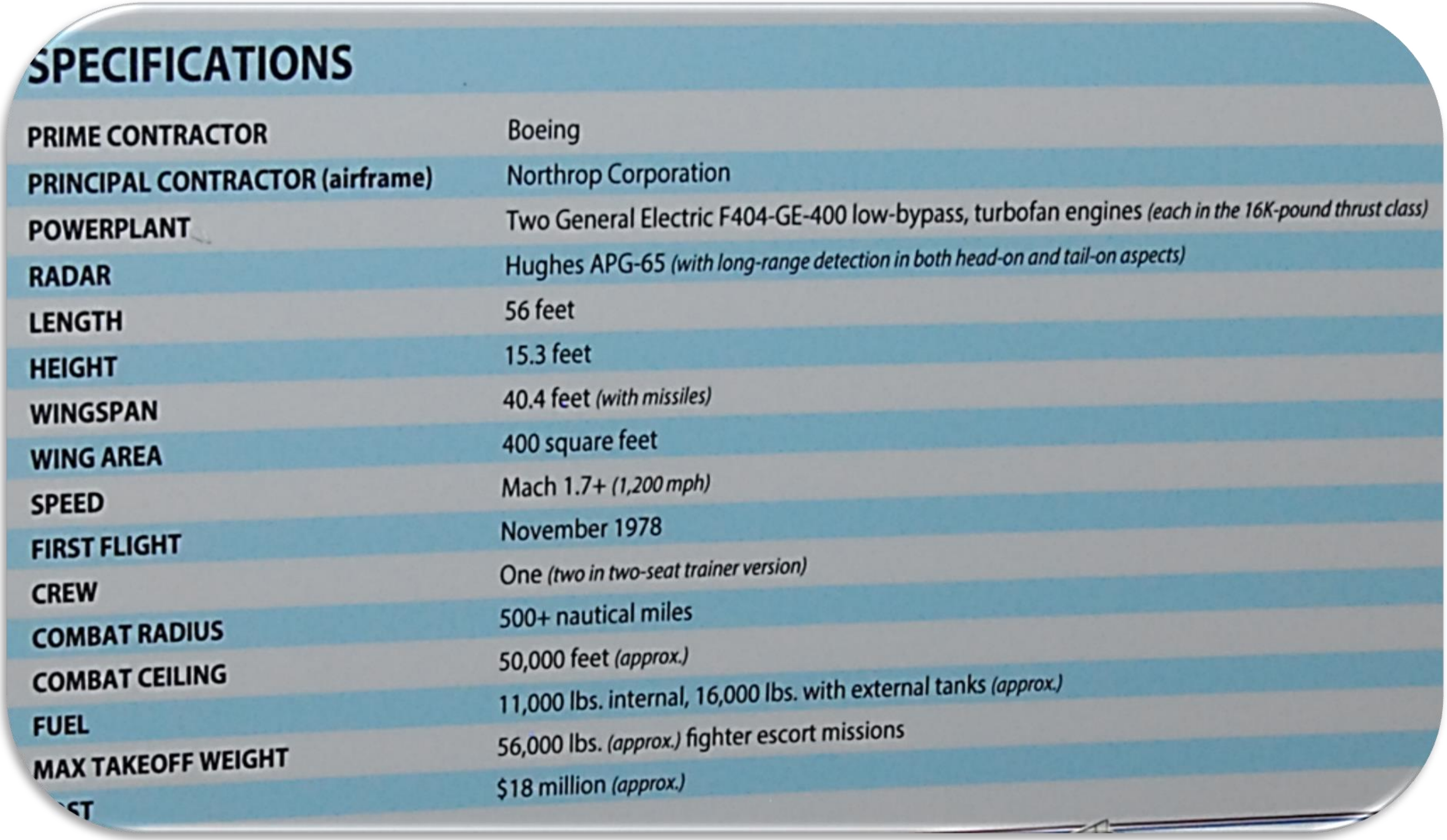
F/A-18A Hornet



SPECIFICATIONS

PRIME CONTRACTOR	Boeing
PRINCIPAL CONTRACTOR (airframe)	Northrop Corporation
POWERPLANT	Two General Electric F404-GE-400 low-bypass, turbofan engines *(each in the 16K-pound thrust class)*
RADAR	Hughes APG-65 *(with long-range detection in both head-on and tail-on aspects)*
LENGTH	56 feet
HEIGHT	15.3 feet
WINGSPAN	40.4 feet *(with missiles)*
WING AREA	400 square feet
SPEED	Mach 1.7+ *(1,200 mph)*
FIRST FLIGHT	November 1978
CREW	One *(two in two-seat trainer version)*
COMBAT RADIUS	500+ nautical miles
COMBAT CEILING	50,000 feet *(approx.)*
FUEL	11,000 lbs. internal, 16,000 lbs. with external tanks *(approx.)*
MAX TAKEOFF WEIGHT	56,000 lbs. *(approx.)* fighter escort missions
ST	$18 million *(approx.)*

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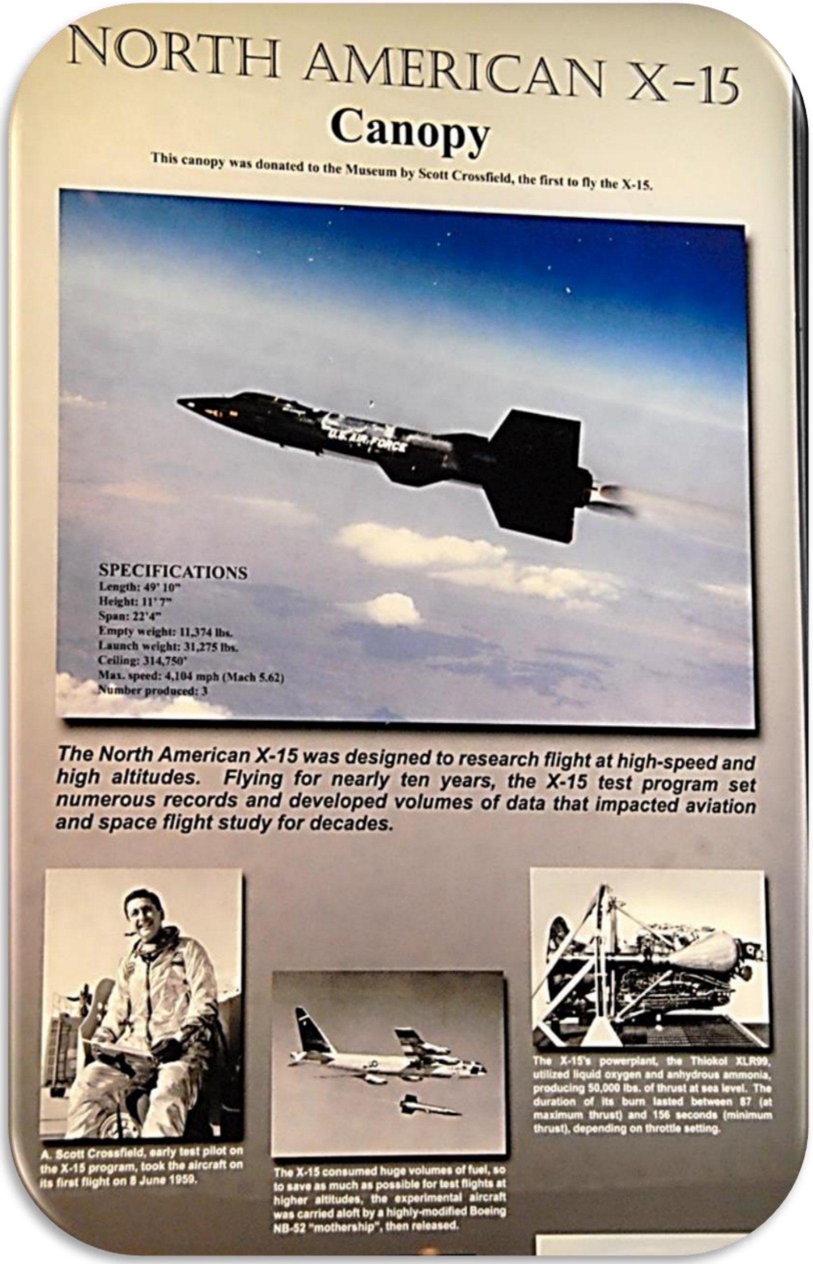

NORTH AMERICAN X-15

Canopy

This canopy was donated to the Museum by Scott Crossfield, the first to fly the X-15.

U.S. AIR FORCE

SPECIFICATIONS
Length: 49' 10"
Height: 11' 7"
Span: 22'4"
Empty weight: 11,374 lbs.
Launch weight: 31,275 lbs.
Ceiling: 314,750'
Max. speed: 4,104 mph (Mach 5.62)
Number produced: 3

The North American X-15 was designed to research flight at high-speed and high altitudes. Flying for nearly ten years, the X-15 test program set numerous records and developed volumes of data that impacted aviation and space flight study for decades.

A. Scott Crossfield, early test pilot on the X-15 program, took the aircraft on its first flight on 8 June 1959.

The X-15 consumed huge volumes of fuel, so to save as much as possible for test flights at higher altitudes, the experimental aircraft was carried aloft by a highly-modified Boeing NB-52 "mothership", then released.

The X-15's powerplant, the Thiokol XLR99, utilized liquid oxygen and anhydrous ammonia, producing 50,000 lbs. of thrust at sea level. The duration of its burn lasted between 87 (at maximum thrust) and 156 seconds (minimum thrust), depending on throttle setting.

1st flight: 1959
(3 built)

Key Points:

The **North American X-15,** a hypersonic rocket-powered aircraft operated by the USAF and NASA. The X-15 set speed and altitude records in the **1960s**, reaching the edge of outer space. Set the **world record for highest speed by a manned, powered aircraft, set in October 1967, by William J. "Pete" Knight; flew at 4,520 miles per hour, or Mach 6.72**; unchallenged as of 2016. **13 flights by eight pilots met space flight criterion** by exceeding the altitude of 50 miles, thus qualifying as being astronauts. The USAF pilots got astronaut wings immediately, civilian pilots awarded NASA astronaut wings in 2005, 35 years later. Of **199 X-15 missions**, two flights (both by Joseph A. Walker) qualified as true space flights per the international definition of a spaceflight by exceeding 62.1 mi in altitude.

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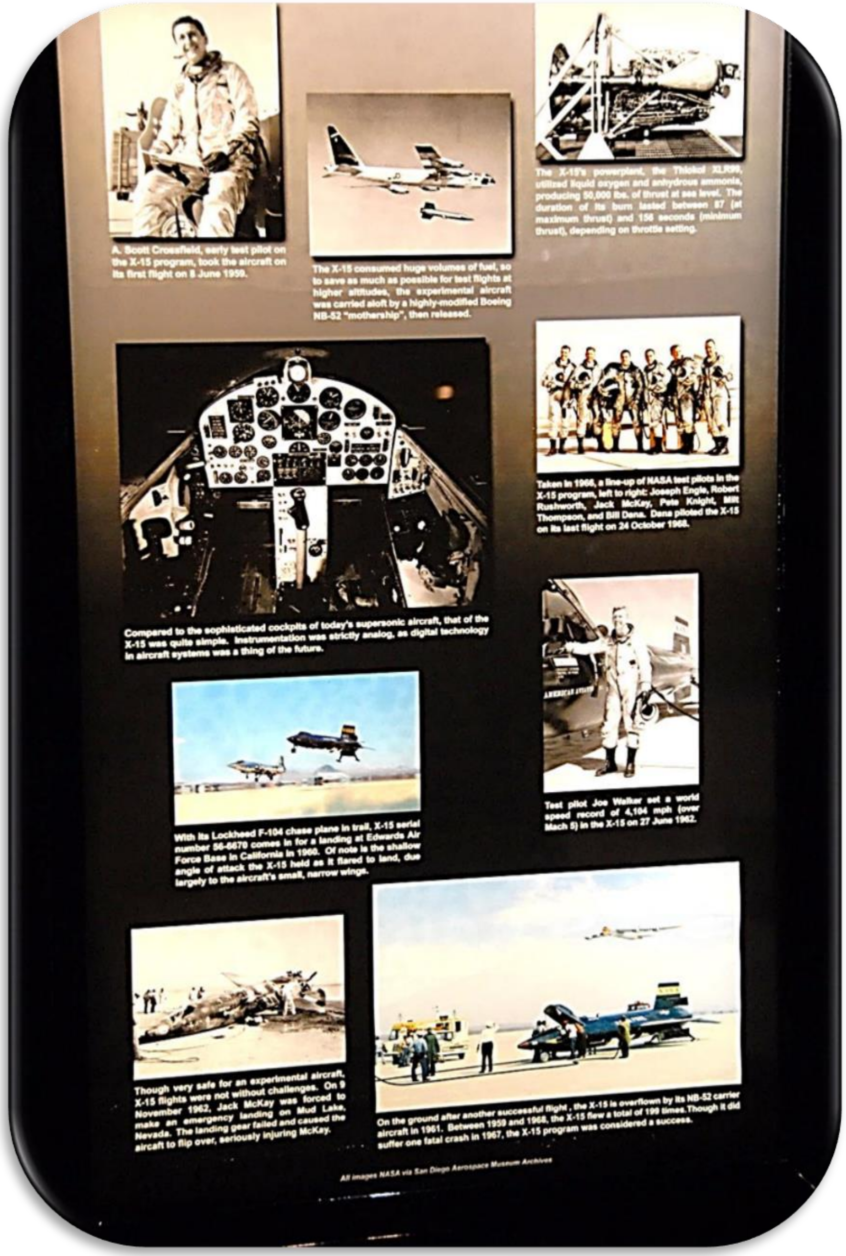

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Compared to the sophisticated cockpits of today's supersonic aircraft, that of the X-15 was quite simple. Instrumentation was strictly analog, as digital technology in aircraft systems was a thing of the future.

Taken in 1966, a line-up of NASA test pilots in the X-15 program, left to right: Joseph Engle, Robert Rushworth, Jack McKay, Pete Knight, Milt Thompson, and Bill Dana. Dana piloted the X-15 on its last flight on 24 October 1968.

With its Lockheed F-104 chase plane in trail, X-15 serial number 56-6670 comes in for a landing at Edwards Air Force Base in California in 1960. Of note is the shallow angle of attack the X-15 held as it flared to land, due largely to the aircraft's small, narrow wings.

Test pilot Joe Walker set a world speed record of 4,104 mph (over Mach 5) in the X-15 on 27 June 1962.

Though very safe for an experimental aircraft, X-15 flights were not without challenges. On 9 November 1962, Jack McKay was forced to make an emergency landing on Mud Lake, Nevada. The landing gear failed and caused the aircaft to flip over, seriously injuring McKay.

On the ground after another successful flight , the X-15 is overflown by its NB-52 carrier aircraft in 1961. Between 1959 and 1968, the X-15 flew a total of 199 times.Though it did suffer one fatal crash in 1967, the X-15 program was considered a success.

All images NASA via San Diego Aerospace Museum Archives

Extra Info:

Three X-15s were built, flying 199 test flights. The first X-15 flight was a unpowered test by Scott Crossfield, on 8 June 1959. Crossfield also piloted the **first powered flight, on 17 September 1959**, and his first flight with the XLR-99 rocket engine on 15 November 1960. **Twelve test pilots flew the X-15**. Among these were **Neil Armstrong**, later a NASA astronaut and first man to set foot on the Moon, and **Joe Engle**, later a commander of NASA Space Shuttle test flights. The **last X-15 flight was on 24 October 1968**.

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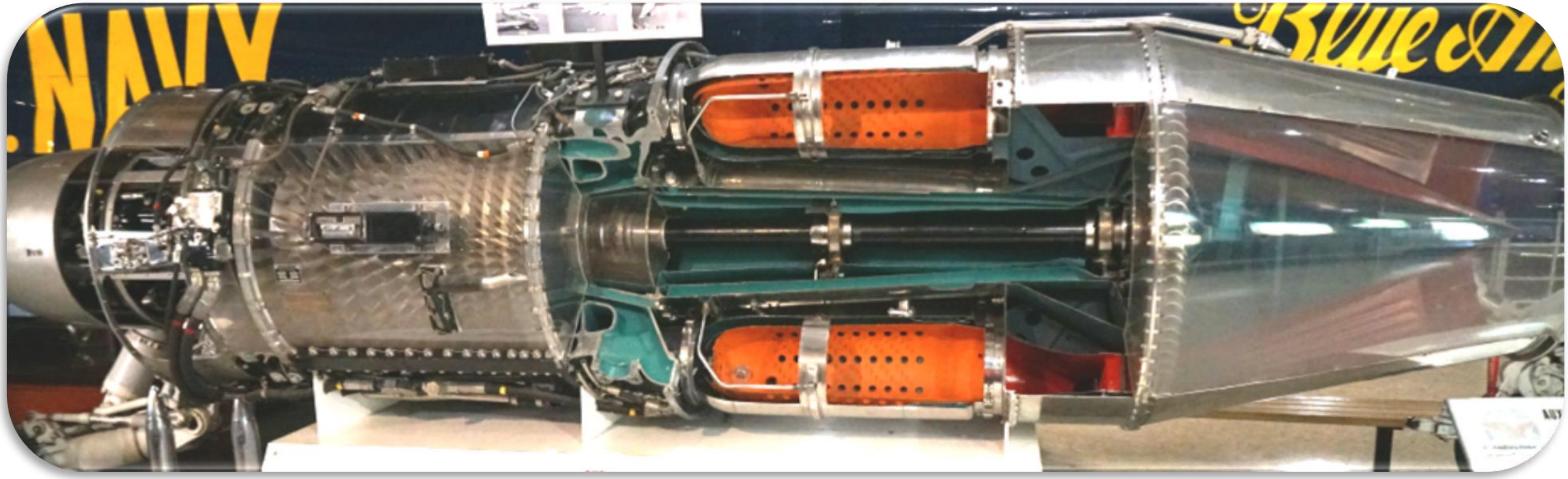
Jet Age Gallery



1st Run: 1948 (30,000+ built)

Key Points: General Electric J-47 Jet Engine. Used in the **F-86 Saber Jet, B-47 Stratojet, and B-36 Peacemaker.** The J47 turbojet (GE company designation TG-190) was developed by General Electric from its earlier J35. It first flew in May 1948. The J47 was the **first axial-flow turbojet approved for commercial use in the United States**. More than **30,000** were manufactured before production ceased in 1956. It saw continued service in the US military until 1978. Packard built 3,025 of the engines under license.

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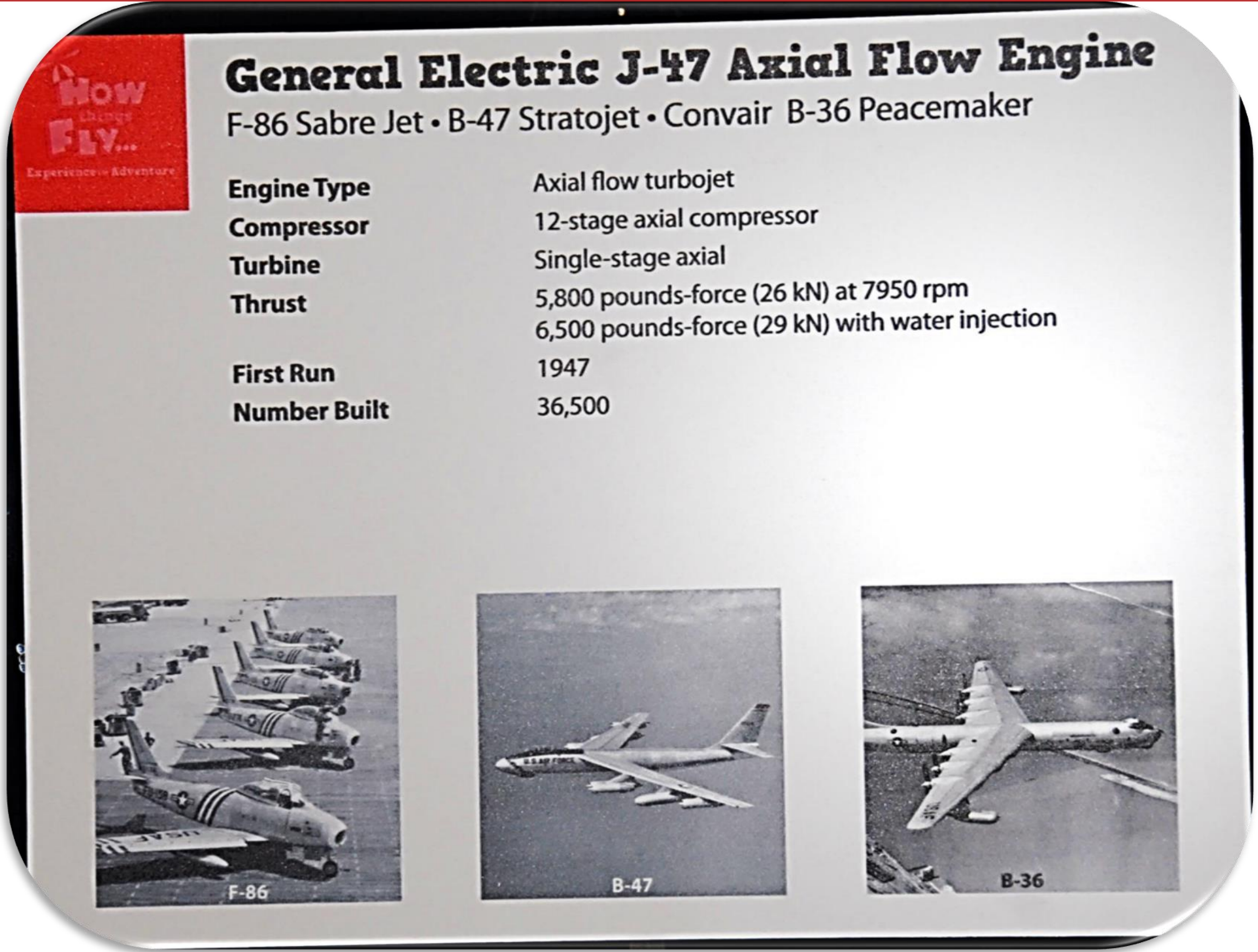

How things Fly...
Experience the Adventure

General Electric J-47 Axial Flow Engine

F-86 Sabre Jet • B-47 Stratojet • Convair B-36 Peacemaker

Engine Type	Axial flow turbojet
Compressor	12-stage axial compressor
Turbine	Single-stage axial
Thrust	5,800 pounds-force (26 kN) at 7950 rpm 6,500 pounds-force (29 kN) with water injection
First Run	1947
Number Built	36,500

F-86

B-47

B-36

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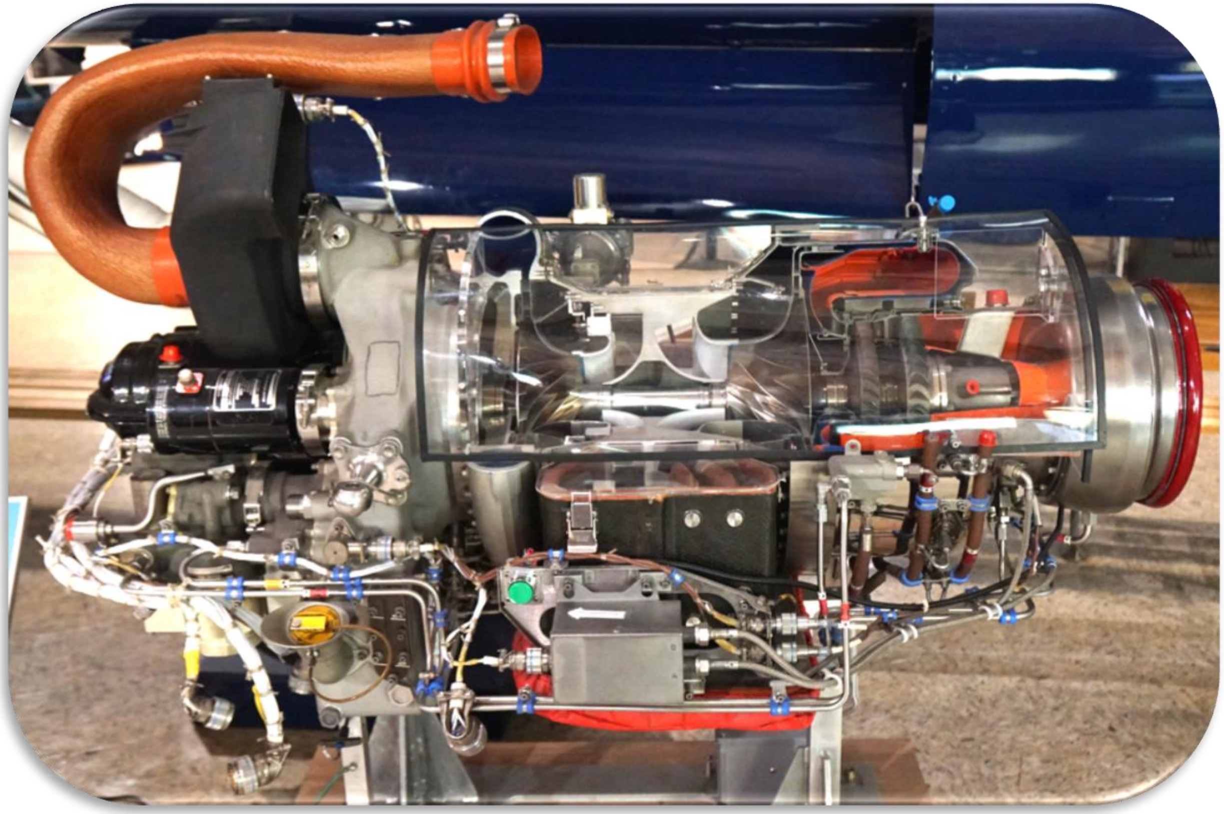

1st Run: 1957

First built in **San Diego** by **Turbomach/Power,** which became **Solar Turbine** then **Sundstrand** then merged with **Pratt & Whitney. Over 30,500 produced.**

Key Points: Auxiliary Power Unit (APU) APS3200 (Original) used on **Airbus** A320, A380, A400M; **Boeing** B-787, B-747-8 & **Military** C-5B aircraft. The APU produces **550 HP** which provides **bleed air** for ground cabin conditioning and main engine starting, concurrent with 90kVA of **electrical power**. It burns the same jet fuel as the main engines and is normally shut down prior to takeoff. Can provide **backup air and electrical power in flight**. The APU is also certified for a **180-minute Extended range Twin engine Operations** (ETOPs).

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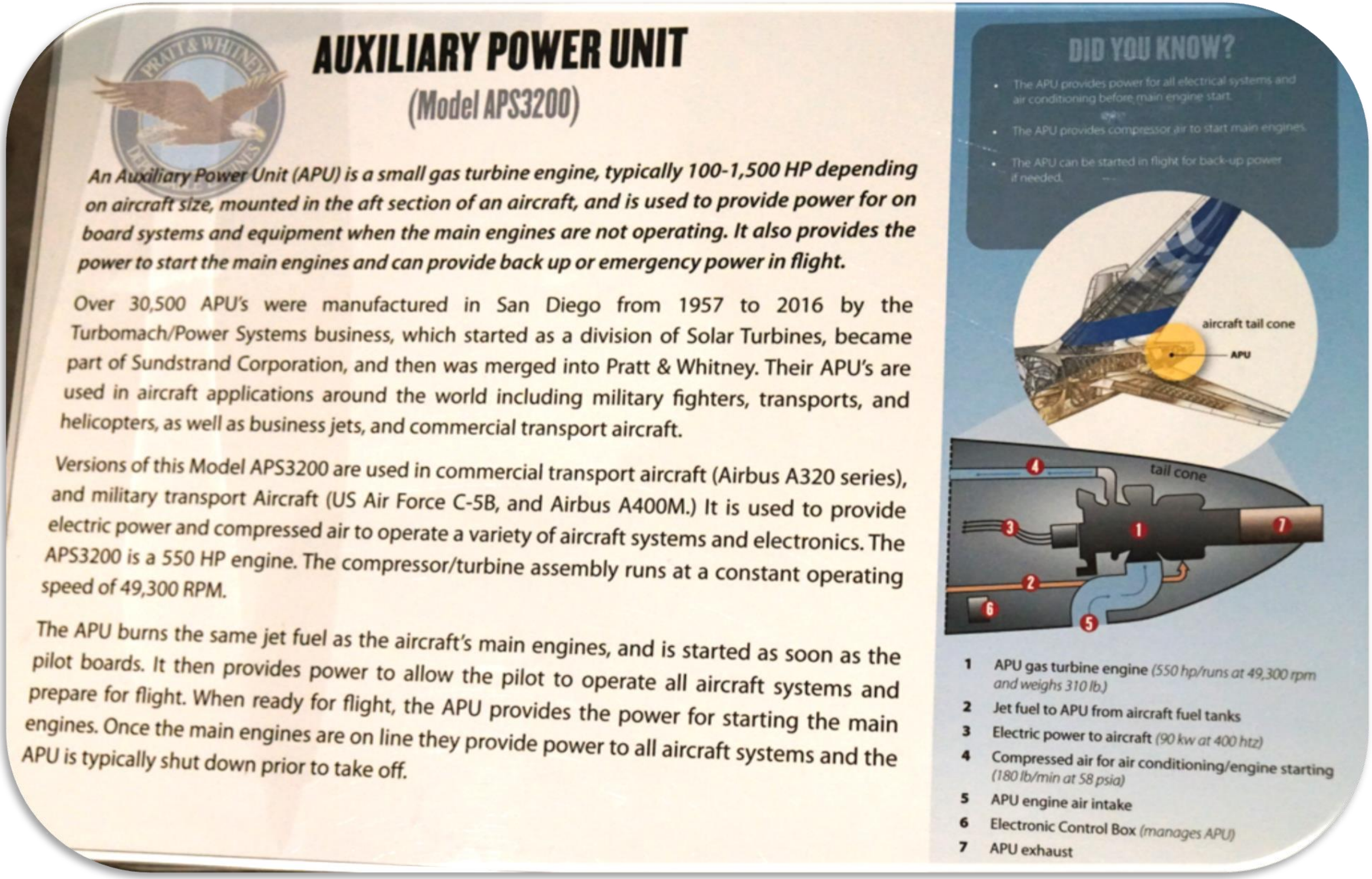

AUXILIARY POWER UNIT

(Model APS3200)

An Auxiliary Power Unit (APU) is a small gas turbine engine, typically 100-1,500 HP depending on aircraft size, mounted in the aft section of an aircraft, and is used to provide power for on board systems and equipment when the main engines are not operating. It also provides the power to start the main engines and can provide back up or emergency power in flight.

Over 30,500 APU's were manufactured in San Diego from 1957 to 2016 by the Turbomach/Power Systems business, which started as a division of Solar Turbines, became part of Sundstrand Corporation, and then was merged into Pratt & Whitney. Their APU's are used in aircraft applications around the world including military fighters, transports, and helicopters, as well as business jets, and commercial transport aircraft.

Versions of this Model APS3200 are used in commercial transport aircraft (Airbus A320 series), and military transport Aircraft (US Air Force C-5B, and Airbus A400M.) It is used to provide electric power and compressed air to operate a variety of aircraft systems and electronics. The APS3200 is a 550 HP engine. The compressor/turbine assembly runs at a constant operating speed of 49,300 RPM.

The APU burns the same jet fuel as the aircraft's main engines, and is started as soon as the pilot boards. It then provides power to allow the pilot to operate all aircraft systems and prepare for flight. When ready for flight, the APU provides the power for starting the main engines. Once the main engines are on line they provide power to all aircraft systems and the APU is typically shut down prior to take off.

DID YOU KNOW?

- The APU provides power for all electrical systems and air conditioning before main engine start.
- The APU provides compressor air to start main engines.
- The APU can be started in flight for back-up power if needed.

1 APU gas turbine engine *(550 hp/runs at 49,300 rpm and weighs 310 lb.)*
2 Jet fuel to APU from aircraft fuel tanks
3 Electric power to aircraft *(90 kw at 400 htz)*
4 Compressed air for air conditioning/engine starting *(180 lb/min at 58 psia)*
5 APU engine air intake
6 Electronic Control Box *(manages APU)*
7 APU exhaust

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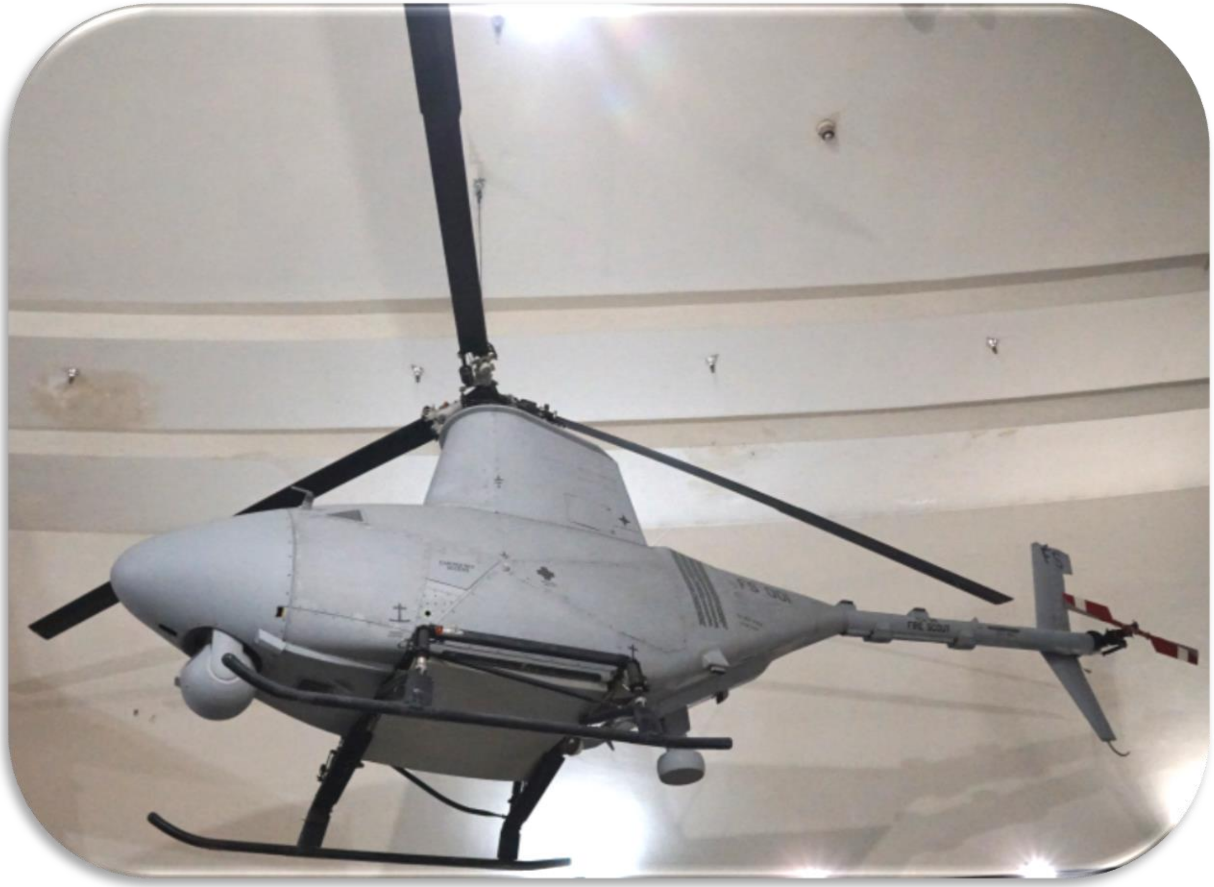

1st Flight: 2000
(30 built)

Key Points: **Northrop Grumman MQ-8 Fire Scout** (Original)
Unmanned autonomous helicopter. Designed to provide **reconnaissance, situational awareness, aerial fire support and precision targeting support** for up to **8 hours** before refueling. 30 Fire Scout's built as of 2014.

Extra Info: Introduced **2009**, Army and Navy continuing development for multiple roles on the battlefield. 115kts top speed, 20K feet service ceiling.

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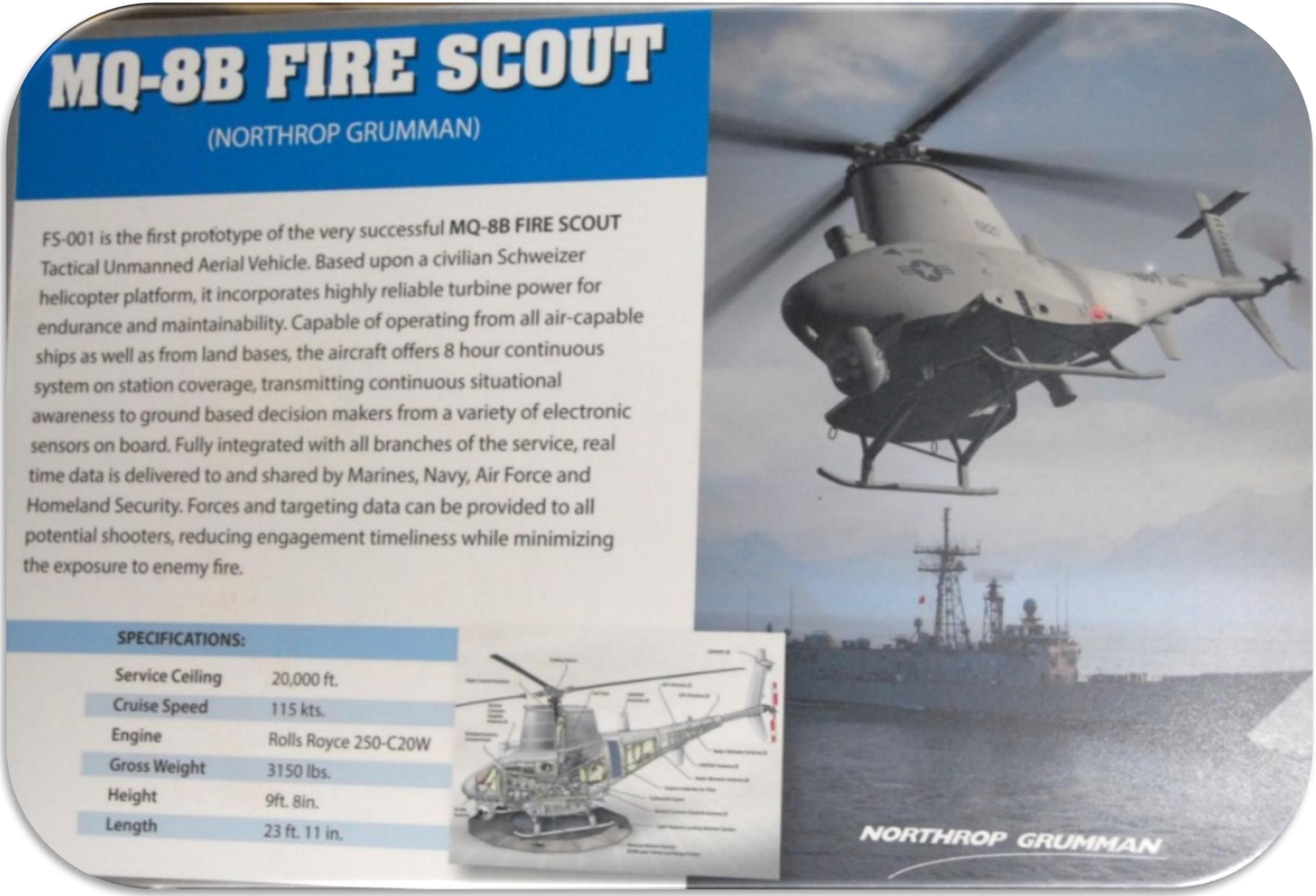


MQ-8B FIRE SCOUT

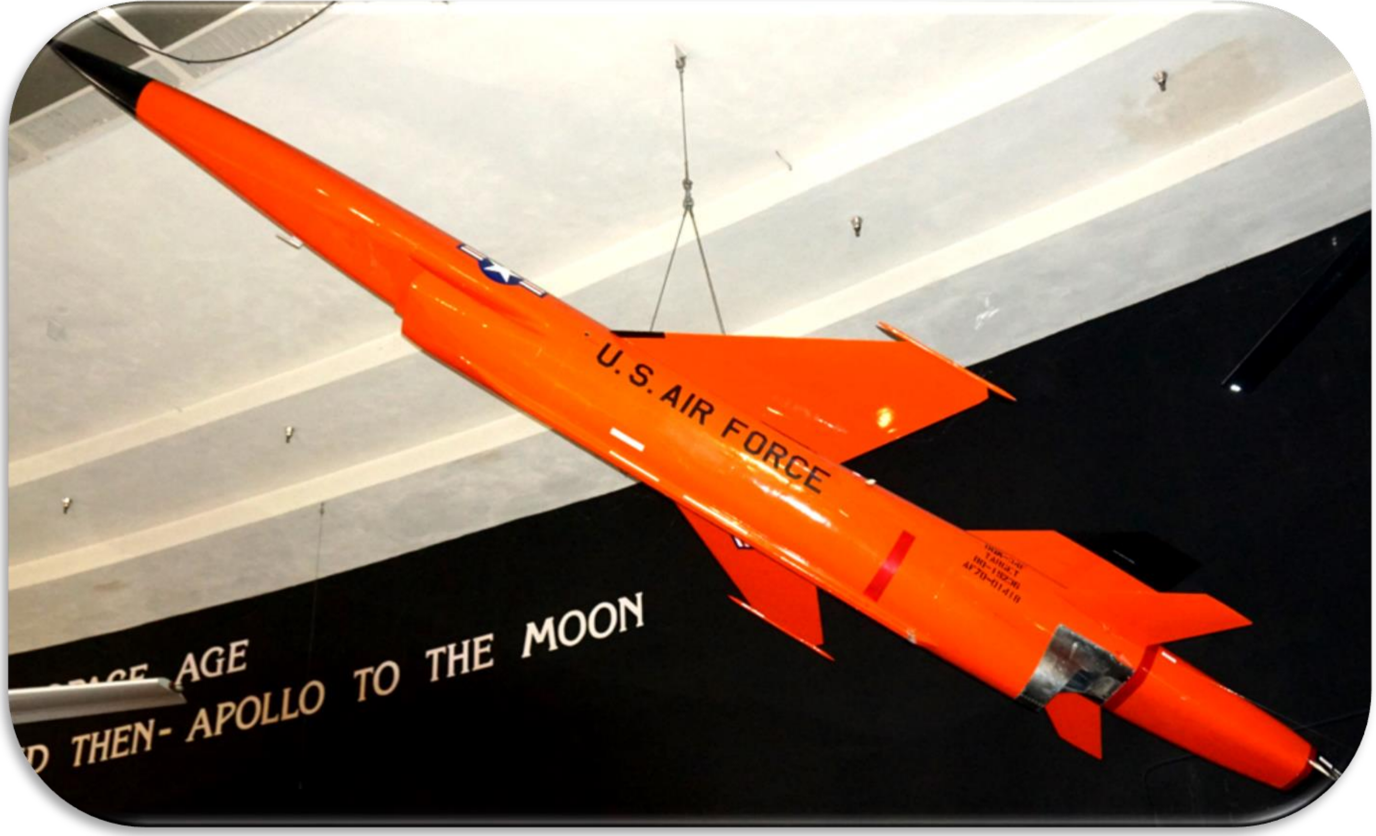
(NORTHROP GRUMMAN)

FS-001 is the first prototype of the very successful **MQ-8B FIRE SCOUT** Tactical Unmanned Aerial Vehicle. Based upon a civilian Schweizer helicopter platform, it incorporates highly reliable turbine power for endurance and maintainability. Capable of operating from all air-capable ships as well as from land bases, the aircraft offers 8 hour continuous system on station coverage, transmitting continuous situational awareness to ground based decision makers from a variety of electronic sensors on board. Fully integrated with all branches of the service, real time data is delivered to and shared by Marines, Navy, Air Force and Homeland Security. Forces and targeting data can be provided to all potential shooters, reducing engagement timeliness while minimizing the exposure to enemy fire.

SPECIFICATIONS:

Service Ceiling	20,000 ft.
Cruise Speed	115 kts.
Engine	Rolls Royce 250-C20W
Gross Weight	3150 lbs.
Height	9ft. 8in.
Length	23 ft. 11 in.

Jet Age Gallery



1st Flight:
1972
(900+ built)

Key Points: **Ryan** BQM-34F **Firebee II Target Drone (Original).** Jet powered, supersonic, radio controlled, recoverable aerial target. Built by **Teledyne Ryan Aeronautical** Company of San Diego. First flight **June 1972**, remained in service until **1990**. Capable of **Mach 1.5** at **55,000 feet** and endurance of **75 minutes**. Powered by a Teledyne CAE J69-T-6 turbojet. Usually launched from a DC-130.

This: Was built in 1970 and flown by the U.S. Air Force. Donated by Teledyne Ryan in 1980.

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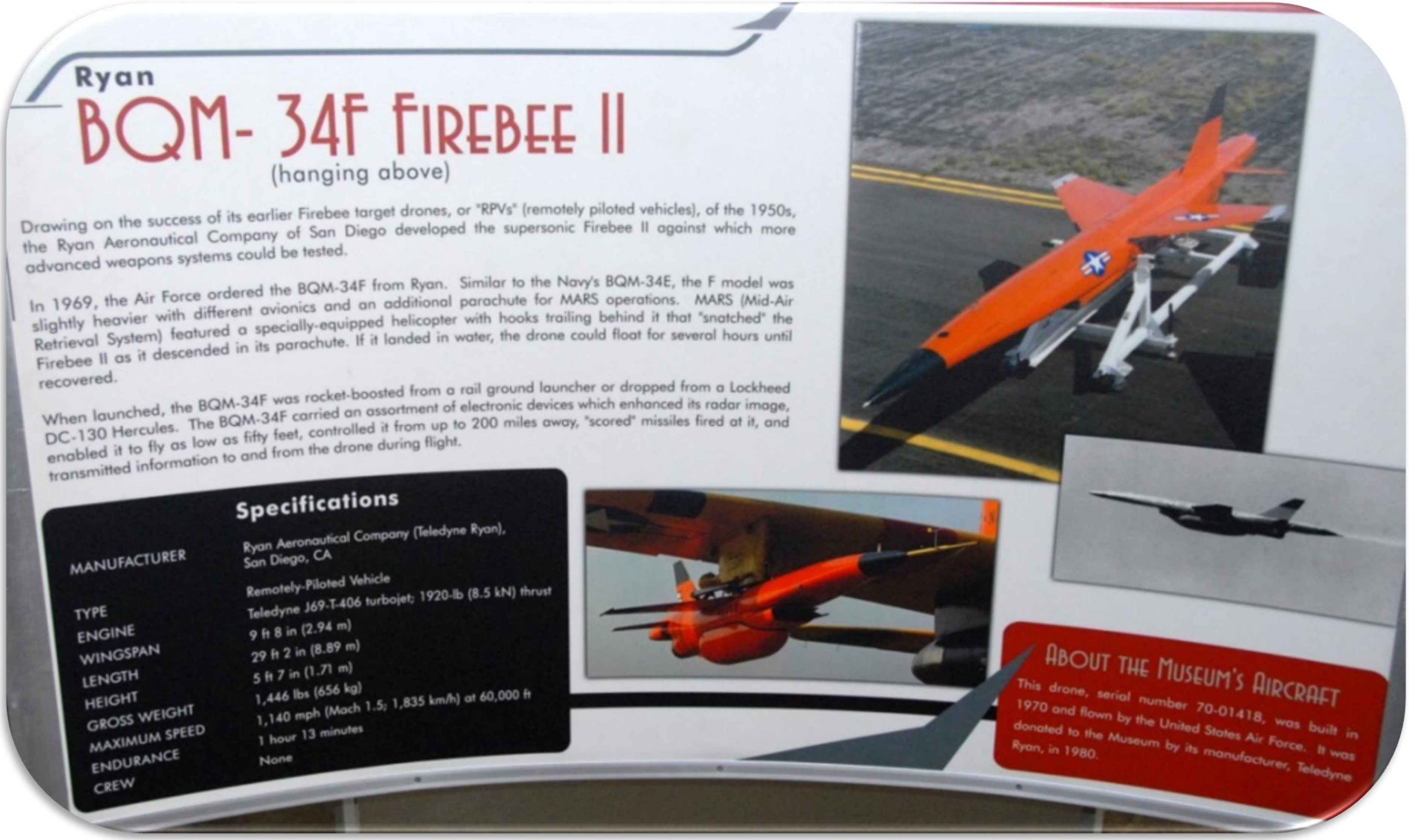

Ryan

BQM- 34F FIREBEE II

(hanging above)

Drawing on the success of its earlier Firebee target drones, or "RPVs" (remotely piloted vehicles), of the 1950s, the Ryan Aeronautical Company of San Diego developed the supersonic Firebee II against which more advanced weapons systems could be tested.

In 1969, the Air Force ordered the BQM-34F from Ryan. Similar to the Navy's BQM-34E, the F model was slightly heavier with different avionics and an additional parachute for MARS operations. MARS (Mid-Air Retrieval System) featured a specially-equipped helicopter with hooks trailing behind it that "snatched" the Firebee II as it descended in its parachute. If it landed in water, the drone could float for several hours until recovered.

When launched, the BQM-34F was rocket-boosted from a rail ground launcher or dropped from a Lockheed DC-130 Hercules. The BQM-34F carried an assortment of electronic devices which enhanced its radar image, enabled it to fly as low as fifty feet, controlled it from up to 200 miles away, "scored" missiles fired at it, and transmitted information to and from the drone during flight.

Specifications

MANUFACTURER	Ryan Aeronautical Company (Teledyne Ryan), San Diego, CA
TYPE	Remotely-Piloted Vehicle
ENGINE	Teledyne J69-T-406 turbojet; 1920-lb (8.5 kN) thrust
WINGSPAN	9 ft 8 in (2.94 m)
LENGTH	29 ft 2 in (8.89 m)
HEIGHT	5 ft 7 in (1.71 m)
GROSS WEIGHT	1,446 lbs (656 kg)
MAXIMUM SPEED	1,140 mph (Mach 1.5; 1,835 km/h) at 60,000 ft
ENDURANCE	1 hour 13 minutes
CREW	None

ABOUT THE MUSEUM'S AIRCRAFT

This drone, serial number 70-01418, was built in 1970 and flown by the United States Air Force. It was donated to the Museum by its manufacturer, Teledyne Ryan, in 1980.

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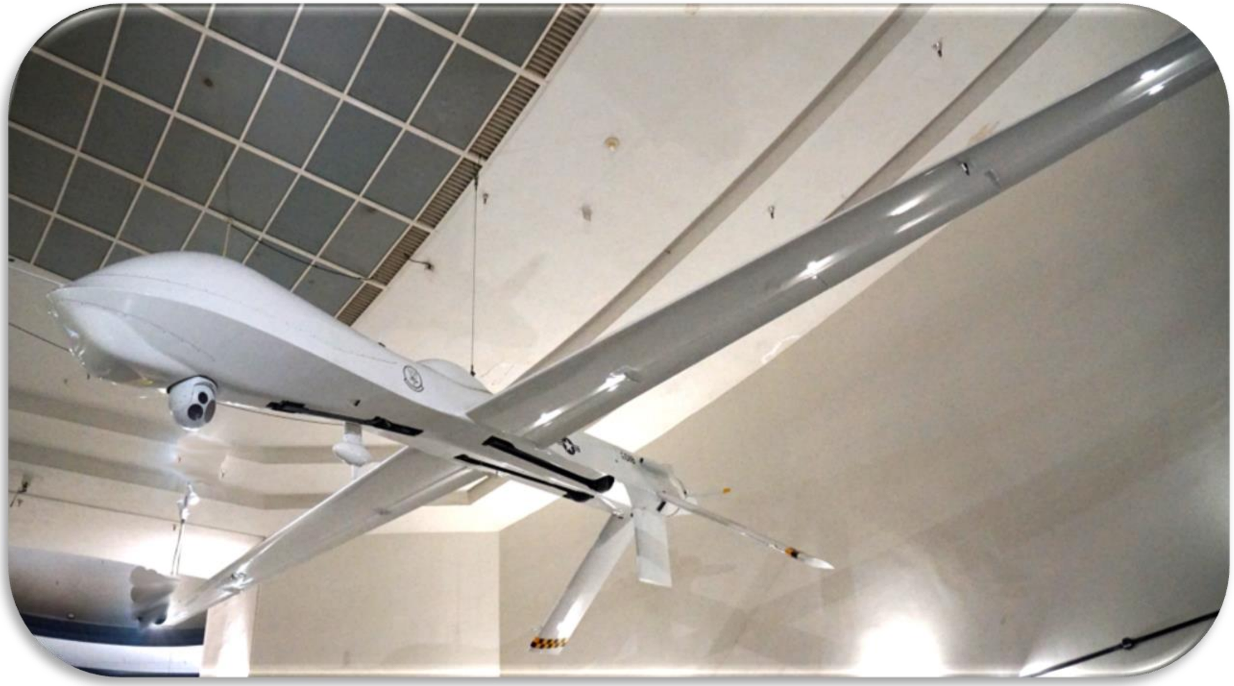

1st Flight: 1994
(360+ built)

This: First flight on Oct 24, **1997**, assigned **Yugoslavia 1999 & 2000**. Flew **418** times. Eighteenth Predator built. **Note:** no '**hard points**' under wings to mount and fire **hellfire missiles**. This is an early Predator, later models could carry 2 missiles on each wing which gave them both targeting and attack capabilities.

Key Points: General Atomics RQ-1K Predator (Original). First missions: Bosnia Jul 95 - Mar 96. Controlled by ground crew thru direct data link or satellite. Capable of **live color video**, **still images**, **radar imagery**, all-weather, day or night via thermographic camera (for low light/night) and/or synthetic aperture radar. **GPS-aided inertial guidance navigation system** & **laser designator** for Hellfire missile targeting. Four cylinder, Rotax piston engine will **cruise 87 mph for 16 to 24 hours @ up to 25K feet.** Over 360 Predators built.

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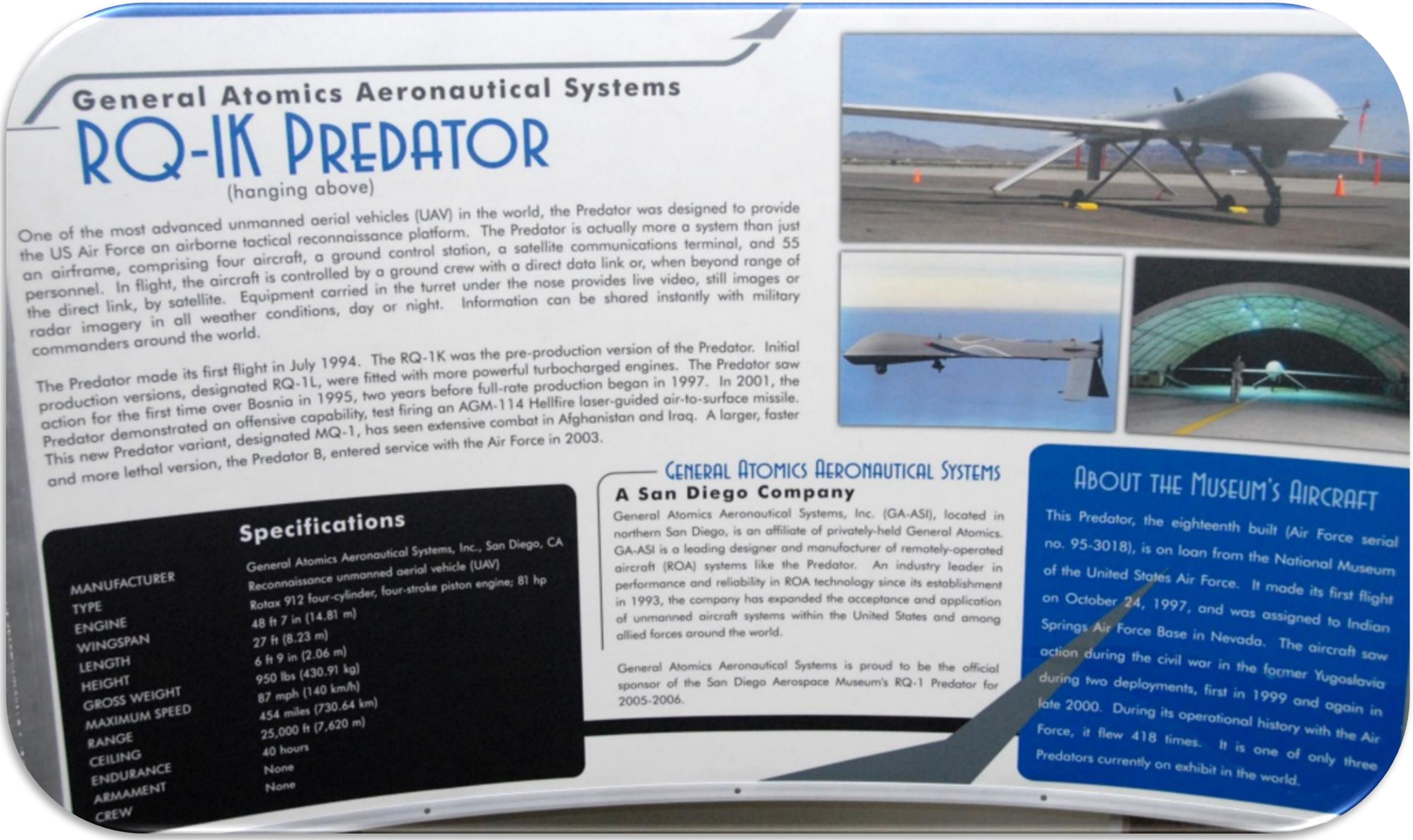

General Atomics Aeronautical Systems

RQ-1K PREDATOR

(hanging above)

One of the most advanced unmanned aerial vehicles (UAV) in the world, the Predator was designed to provide the US Air Force an airborne tactical reconnaissance platform. The Predator is actually more a system than just an airframe, comprising four aircraft, a ground control station, a satellite communications terminal, and 55 personnel. In flight, the aircraft is controlled by a ground crew with a direct data link or, when beyond range of the direct link, by satellite. Equipment carried in the turret under the nose provides live video, still images or radar imagery in all weather conditions, day or night. Information can be shared instantly with military commanders around the world.

The Predator made its first flight in July 1994. The RQ-1K was the pre-production version of the Predator. Initial production versions, designated RQ-1L, were fitted with more powerful turbocharged engines. The Predator saw action for the first time over Bosnia in 1995, two years before full-rate production began in 1997. In 2001, the Predator demonstrated an offensive capability, test firing an AGM-114 Hellfire laser-guided air-to-surface missile. This new Predator variant, designated MQ-1, has seen extensive combat in Afghanistan and Iraq. A larger, faster and more lethal version, the Predator B, entered service with the Air Force in 2003.

Specifications

MANUFACTURER	General Atomics Aeronautical Systems, Inc., San Diego, CA
TYPE	Reconnaissance unmanned aerial vehicle (UAV)
ENGINE	Rotax 912 four-cylinder, four-stroke piston engine; 81 hp
WINGSPAN	48 ft 7 in (14.81 m)
LENGTH	27 ft (8.23 m)
HEIGHT	6 ft 9 in (2.06 m)
GROSS WEIGHT	950 lbs (430.91 kg)
MAXIMUM SPEED	87 mph (140 km/h)
RANGE	454 miles (730.64 km)
CEILING	25,000 ft (7,620 m)
ENDURANCE	40 hours
ARMAMENT	None
CREW	None

GENERAL ATOMICS AERONAUTICAL SYSTEMS

A San Diego Company

General Atomics Aeronautical Systems, Inc. (GA-ASI), located in northern San Diego, is an affiliate of privately-held General Atomics. GA-ASI is a leading designer and manufacturer of remotely-operated aircraft (ROA) systems like the Predator. An industry leader in performance and reliability in ROA technology since its establishment in 1993, the company has expanded the acceptance and application of unmanned aircraft systems within the United States and among allied forces around the world.

General Atomics Aeronautical Systems is proud to be the official sponsor of the San Diego Aerospace Museum's RQ-1 Predator for 2005-2006.

ABOUT THE MUSEUM'S AIRCRAFT

This Predator, the eighteenth built (Air Force serial no. 95-3018), is on loan from the National Museum of the United States Air Force. It made its first flight on October 24, 1997, and was assigned to Indian Springs Air Force Base in Nevada. The aircraft saw action during the civil war in the former Yugoslavia during two deployments, first in 1999 and again in late 2000. During its operational history with the Air Force, it flew 418 times. It is one of only three Predators currently on exhibit in the world.

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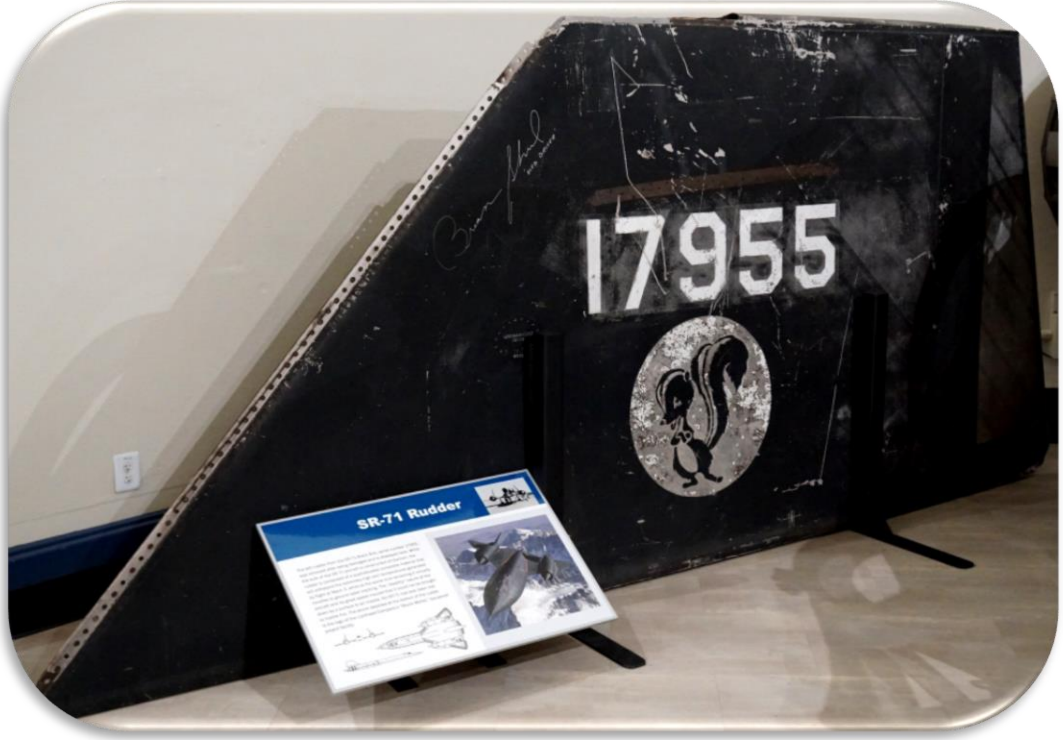

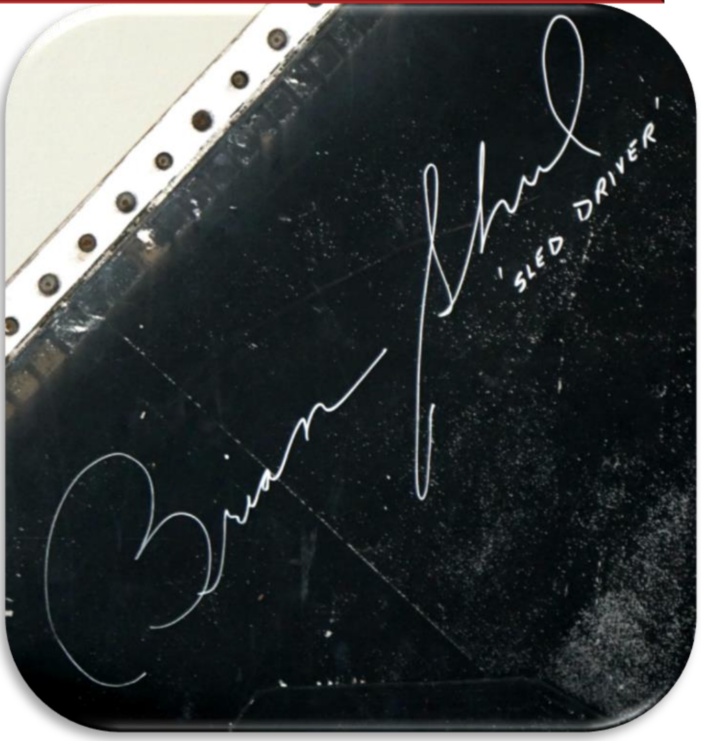

Key Points: SR-71 Rudder (Original) Left rudder from SR-71 17955, removed due to damage. While 93% of the SR-71 is made from titanium, rudders are **made from complex composites** to resist extreme high flight temperatures at Mach 3, and to reduce radar returns from ground tracking stations. Speed and “stealthy” construction resulted in **no SR-71 loses due to hostile fire**. Skunk logo is for Lockheed Company’s **“Skunk Works”.**

This: Signed by **Maj. Brian Shul,** Vietnam War-era USAF attack pilot who flew 212 Vietnam combat missions and was shot down in a T-28 in 1973. Badly burned (given slim chance to live), he survived & returned to flight status flying the SR-71 Blackbird. He has written five books (+2 revisions) on flying and flight photography.

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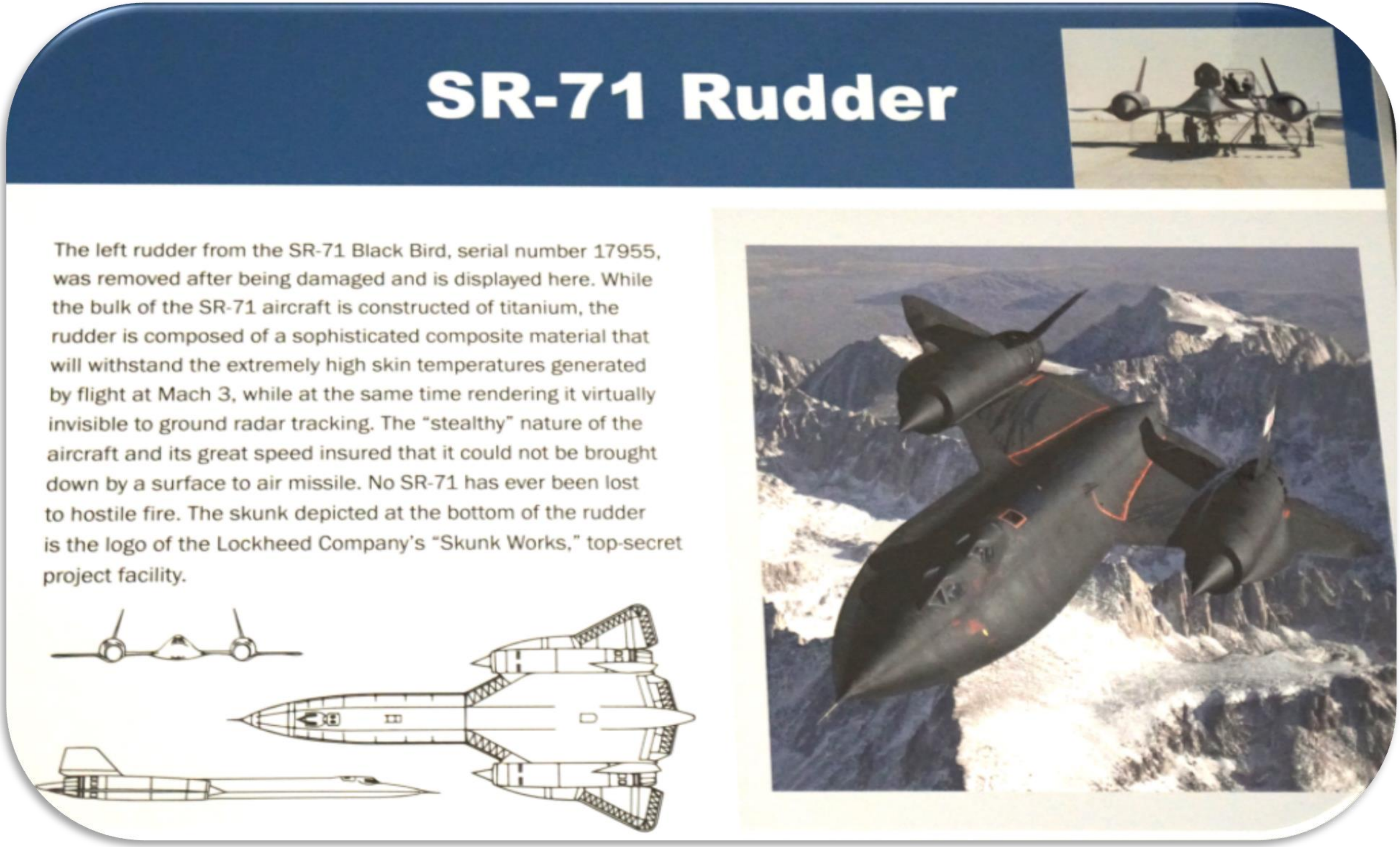

SR-71 Rudder

The left rudder from the SR-71 Black Bird, serial number 17955, was removed after being damaged and is displayed here. While the bulk of the SR-71 aircraft is constructed of titanium, the rudder is composed of a sophisticated composite material that will withstand the extremely high skin temperatures generated by flight at Mach 3, while at the same time rendering it virtually invisible to ground radar tracking. The "stealthy" nature of the aircraft and its great speed insured that it could not be brought down by a surface to air missile. No SR-71 has ever been lost to hostile fire. The skunk depicted at the bottom of the rudder is the logo of the Lockheed Company's "Skunk Works," top-secret project facility.

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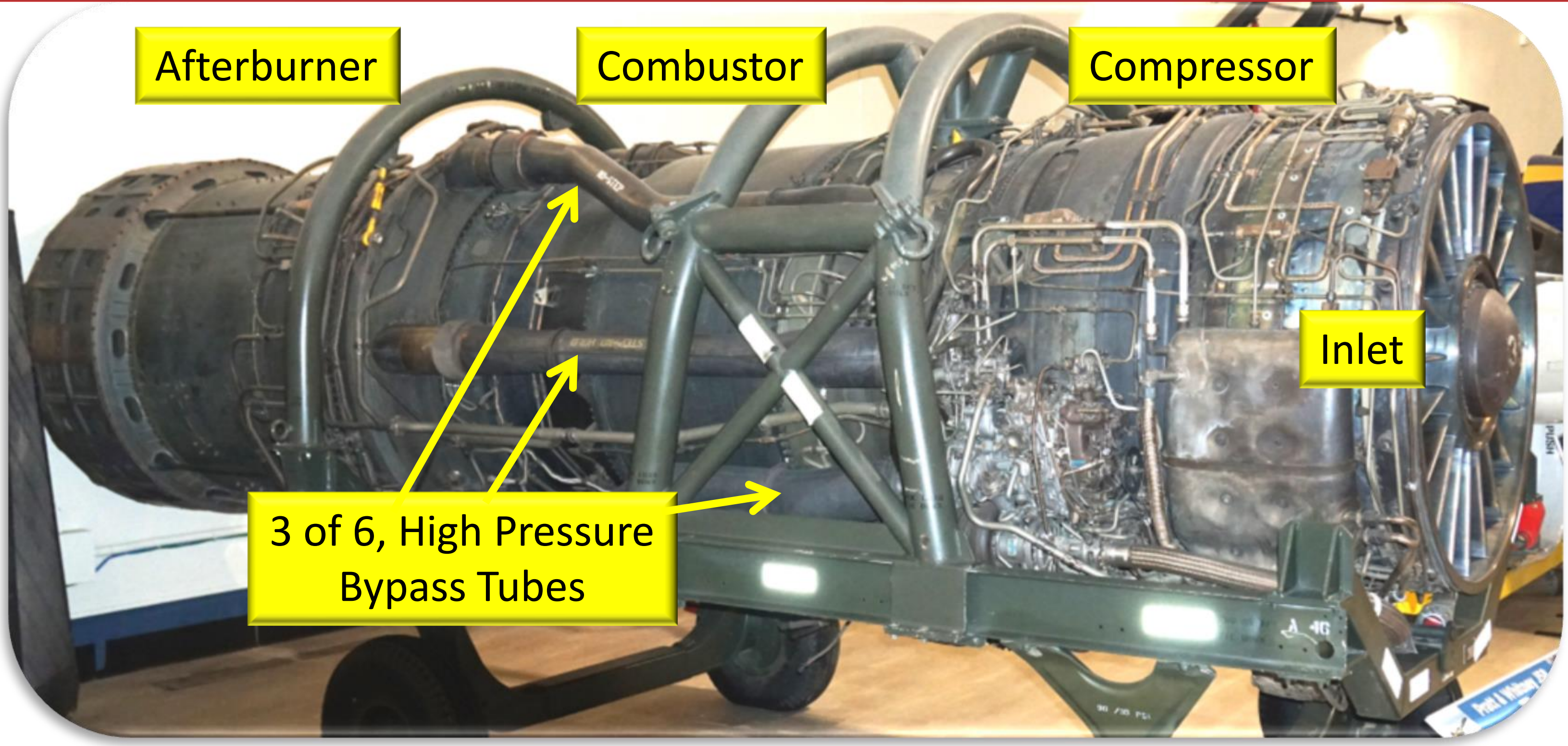
Afterburner
Combustor
Compressor
Inlet
3 of 6, High Pressure Bypass Tubes

Key Points: **Pratt & Whitney J58 (Original)** Engine that powered the **Lockheed A-12, YF-12 and SR-71 aircraft**. First engine qualified to operate at speeds exceeding **Mach 3 and altitudes above 85,000ft**. Unique feature is bleeding a measure of high-pressure air from the compressor, bypassing the combustion chambers and turbine, then injecting this air into the front of the afterburner enabling increased thrust at high speeds. Combination of the air bleed-bypass system and feeding air directly to the afterburner works much like a ramjet above Mach 2. Up to **34,500 pounds of thrust**.

This: One of the two engines from SDASM's A-12.

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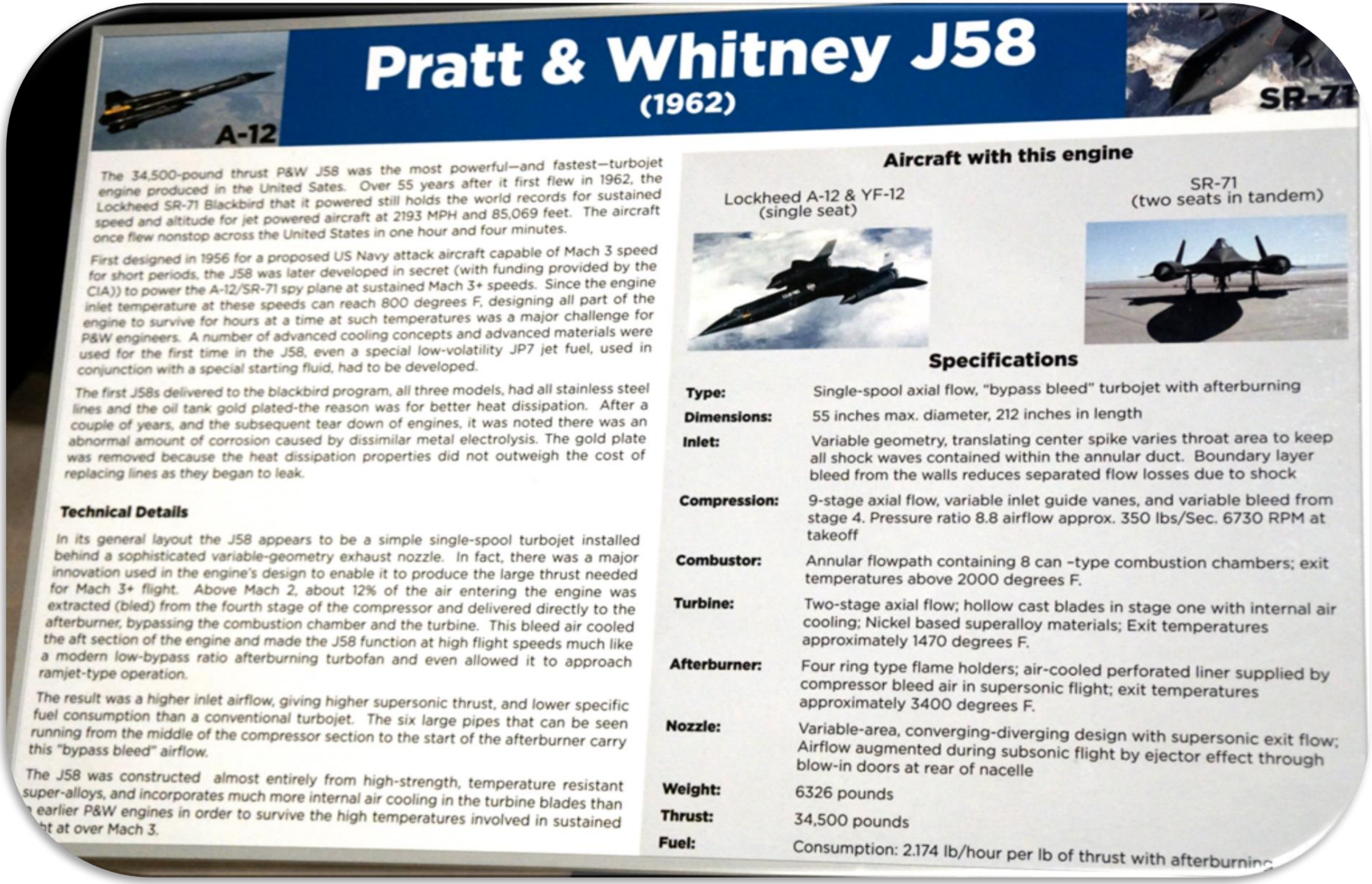

Pratt & Whitney J58

(1962)

The 34,500-pound thrust P&W J58 was the most powerful—and fastest—turbojet engine produced in the United Sates. Over 55 years after it first flew in 1962, the Lockheed SR-71 Blackbird that it powered still holds the world records for sustained speed and altitude for jet powered aircraft at 2193 MPH and 85,069 feet. The aircraft once flew nonstop across the United States in one hour and four minutes.

First designed in 1956 for a proposed US Navy attack aircraft capable of Mach 3 speed for short periods, the J58 was later developed in secret (with funding provided by the CIA)) to power the A-12/SR-71 spy plane at sustained Mach 3+ speeds. Since the engine inlet temperature at these speeds can reach 800 degrees F, designing all part of the engine to survive for hours at a time at such temperatures was a major challenge for P&W engineers. A number of advanced cooling concepts and advanced materials were used for the first time in the J58, even a special low-volatility JP7 jet fuel, used in conjunction with a special starting fluid, had to be developed.

The first J58s delivered to the blackbird program, all three models, had all stainless steel lines and the oil tank gold plated-the reason was for better heat dissipation. After a couple of years, and the subsequent tear down of engines, it was noted there was an abnormal amount of corrosion caused by dissimilar metal electrolysis. The gold plate was removed because the heat dissipation properties did not outweigh the cost of replacing lines as they began to leak.

Technical Details

In its general layout the J58 appears to be a simple single-spool turbojet installed behind a sophisticated variable-geometry exhaust nozzle. In fact, there was a major innovation used in the engine's design to enable it to produce the large thrust needed for Mach 3+ flight. Above Mach 2, about 12% of the air entering the engine was extracted (bled) from the fourth stage of the compressor and delivered directly to the afterburner, bypassing the combustion chamber and the turbine. This bleed air cooled the aft section of the engine and made the J58 function at high flight speeds much like a modern low-bypass ratio afterburning turbofan and even allowed it to approach ramjet-type operation.

The result was a higher inlet airflow, giving higher supersonic thrust, and lower specific fuel consumption than a conventional turbojet. The six large pipes that can be seen running from the middle of the compressor section to the start of the afterburner carry this "bypass bleed" airflow.

The J58 was constructed almost entirely from high-strength, temperature resistant super-alloys, and incorporates much more internal air cooling in the turbine blades than earlier P&W engines in order to survive the high temperatures involved in sustained ht at over Mach 3.

Aircraft with this engine

Lockheed A-12 & YF-12
(single seat)

SR-71
(two seats in tandem)

Specifications

Type:	Single-spool axial flow, "bypass bleed" turbojet with afterburning
Dimensions:	55 inches max. diameter, 212 inches in length
Inlet:	Variable geometry, translating center spike varies throat area to keep all shock waves contained within the annular duct. Boundary layer bleed from the walls reduces separated flow losses due to shock
Compression:	9-stage axial flow, variable inlet guide vanes, and variable bleed from stage 4. Pressure ratio 8.8 airflow approx. 350 lbs/Sec. 6730 RPM at takeoff
Combustor:	Annular flowpath containing 8 can –type combustion chambers; exit temperatures above 2000 degrees F.
Turbine:	Two-stage axial flow; hollow cast blades in stage one with internal air cooling; Nickel based superalloy materials; Exit temperatures approximately 1470 degrees F.
Afterburner:	Four ring type flame holders; air-cooled perforated liner supplied by compressor bleed air in supersonic flight; exit temperatures approximately 3400 degrees F.
Nozzle:	Variable-area, converging-diverging design with supersonic exit flow; Airflow augmented during subsonic flight by ejector effect through blow-in doors at rear of nacelle
Weight:	6326 pounds
Thrust:	34,500 pounds
Fuel:	Consumption: 2.174 lb/hour per lb of thrust with afterburnin

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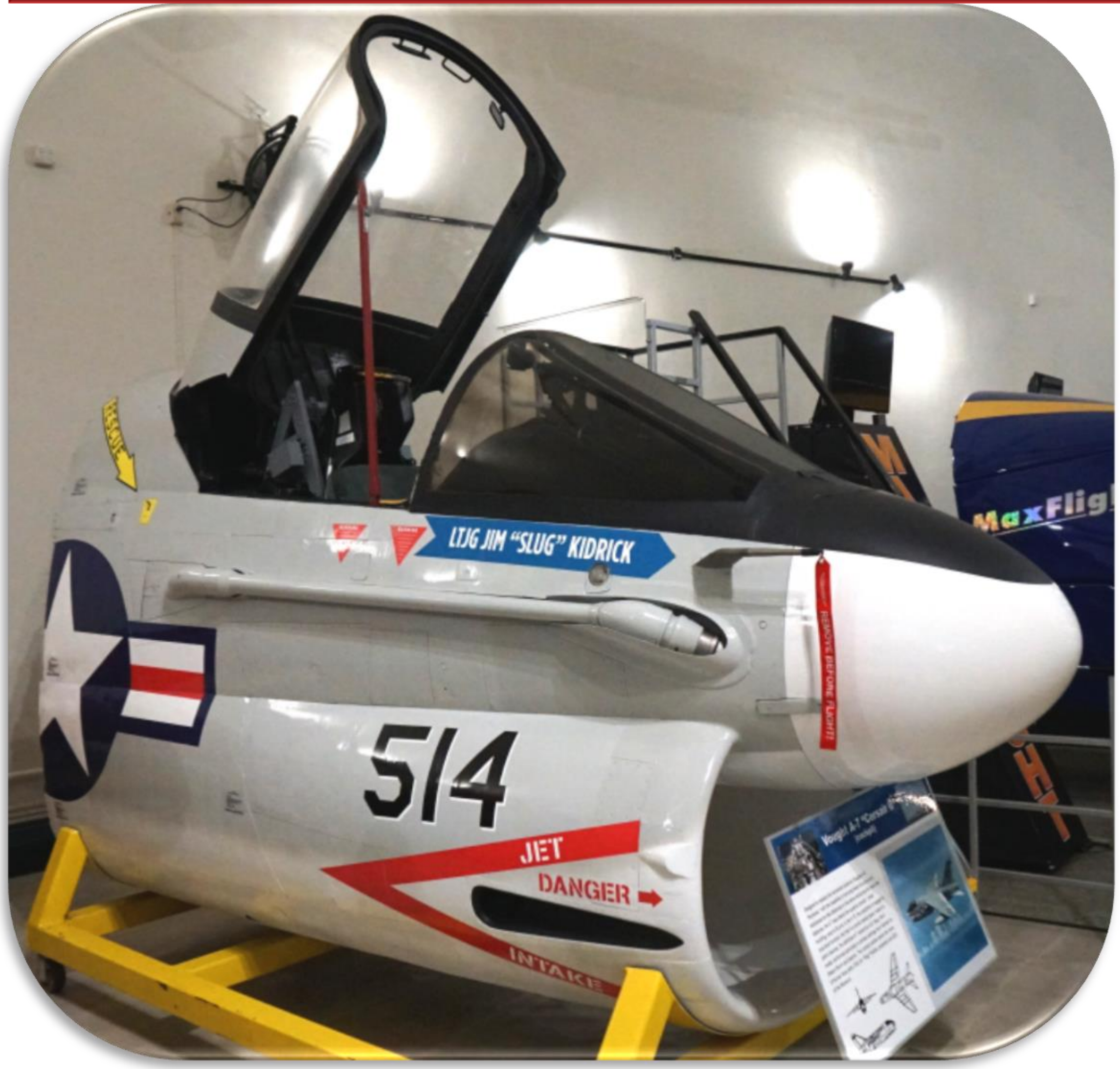
LTJG JIM "SLUG" KIDRICK
514
JET
DANGER
INTAKE
REMOVE BEFORE FLIGHT
MaxFlig

1st Flight: 1965
(1545 built)

Key Points: **Vought A-7 "Corsair II" Cockpit. (Original)** A **lightweight, carrier based attack aircraft**. First Vietnam combat in 1967. **One of 1st aircraft with heads-up display (HUD), inertial navigation system (INS), a turbofan engine and Forward-Looking-InfraRed (FLIR)**. **One of the most accurate strike aircraft ever built.** In Vietnam & Desert Storm, it was successful in every attack role. A total of **1,545 A-7 Corsair IIs were built**. The fleet retired in 1991.

This: Artifact bears the name of **Jim Kidrick**, President & CEO (2006 to Present) of the SDASM and retired Navy Commander who flew the A-7 as a Carrier based Command Pilot.

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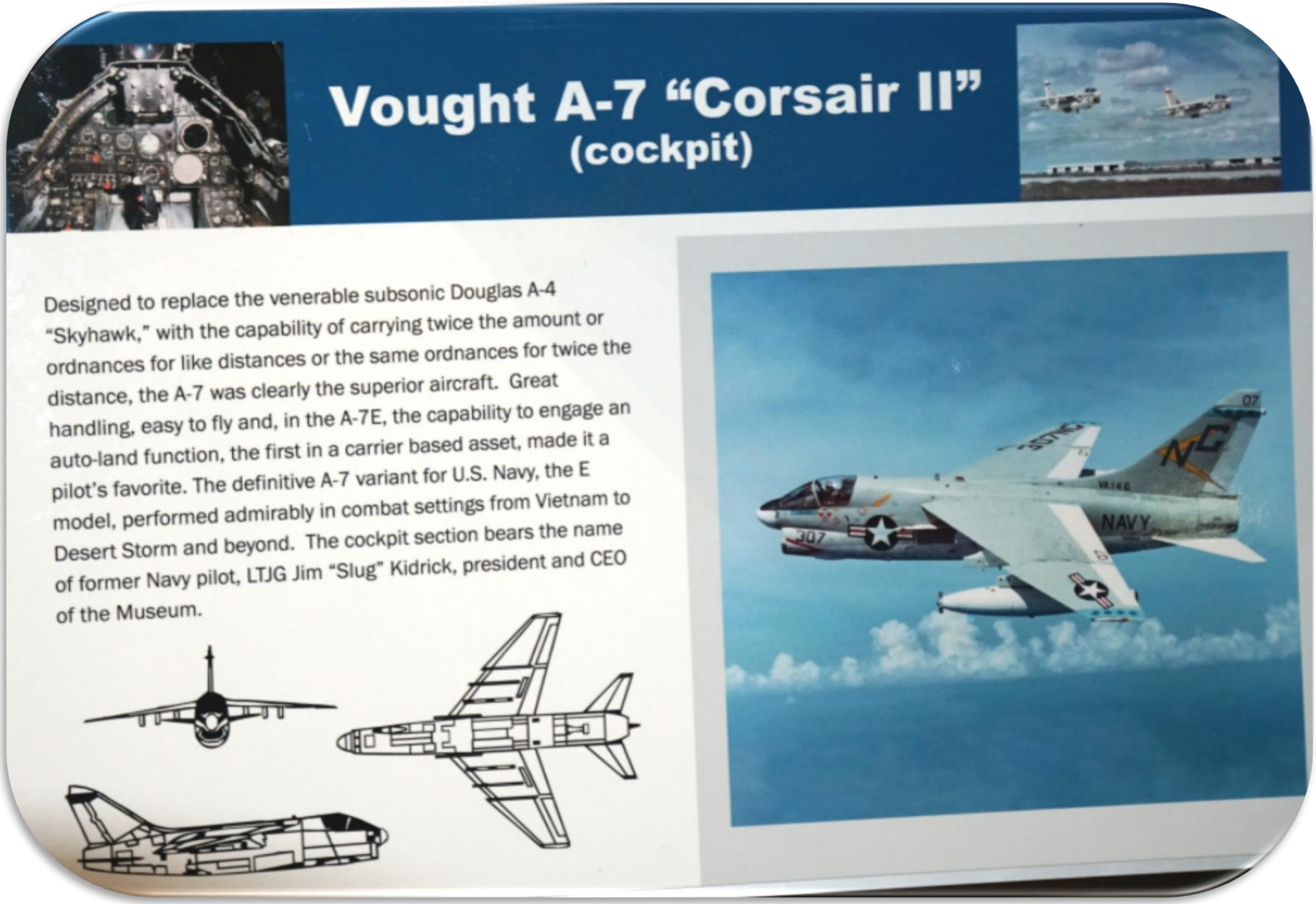

Vought A-7 "Corsair II"

(cockpit)

Designed to replace the venerable subsonic Douglas A-4 "Skyhawk," with the capability of carrying twice the amount or ordnances for like distances or the same ordnances for twice the distance, the A-7 was clearly the superior aircraft. Great handling, easy to fly and, in the A-7E, the capability to engage an auto-land function, the first in a carrier based asset, made it a pilot's favorite. The definitive A-7 variant for U.S. Navy, the E model, performed admirably in combat settings from Vietnam to Desert Storm and beyond. The cockpit section bears the name of former Navy pilot, LTJG Jim "Slug" Kidrick, president and CEO of the Museum.

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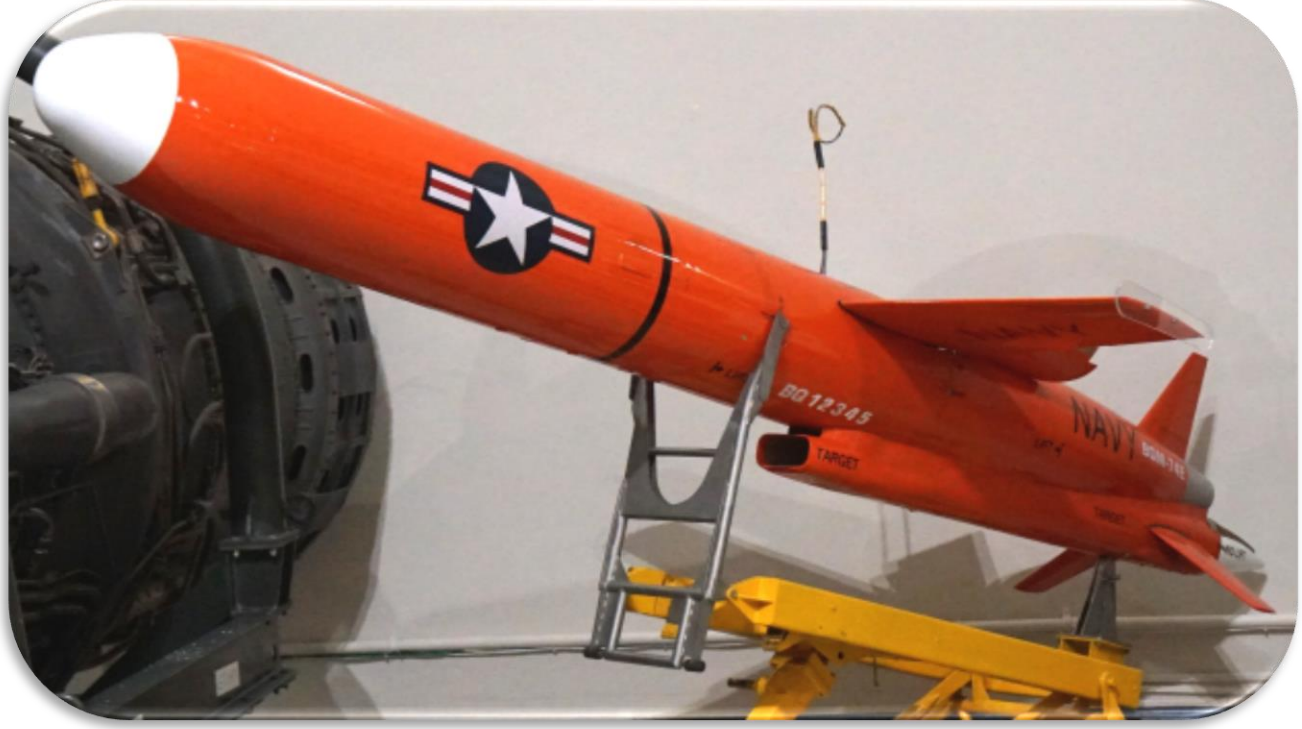

1st Flight:
1965
(4800+ built)

Key Points: **BQM-74 Chukar** (**Original**) are a series of aerial target drones produced by Northrop. They are recoverable, remote controlled, subsonic aerial targets, capable of speeds up to **Mach 0.86** and altitudes from **30,000 to 40,000 ft.**

Extra Info: First used in **1968.** **Later used** in the **1991 Gulf War as decoys**. Many Chukar's were launched over **Baghdad** to saturate Iraqi radar with targets. When Iraqi radar targeted the drones, allied strike aircraft were able to locate the radar sites and neutralize the radar with HARM missile strikes.

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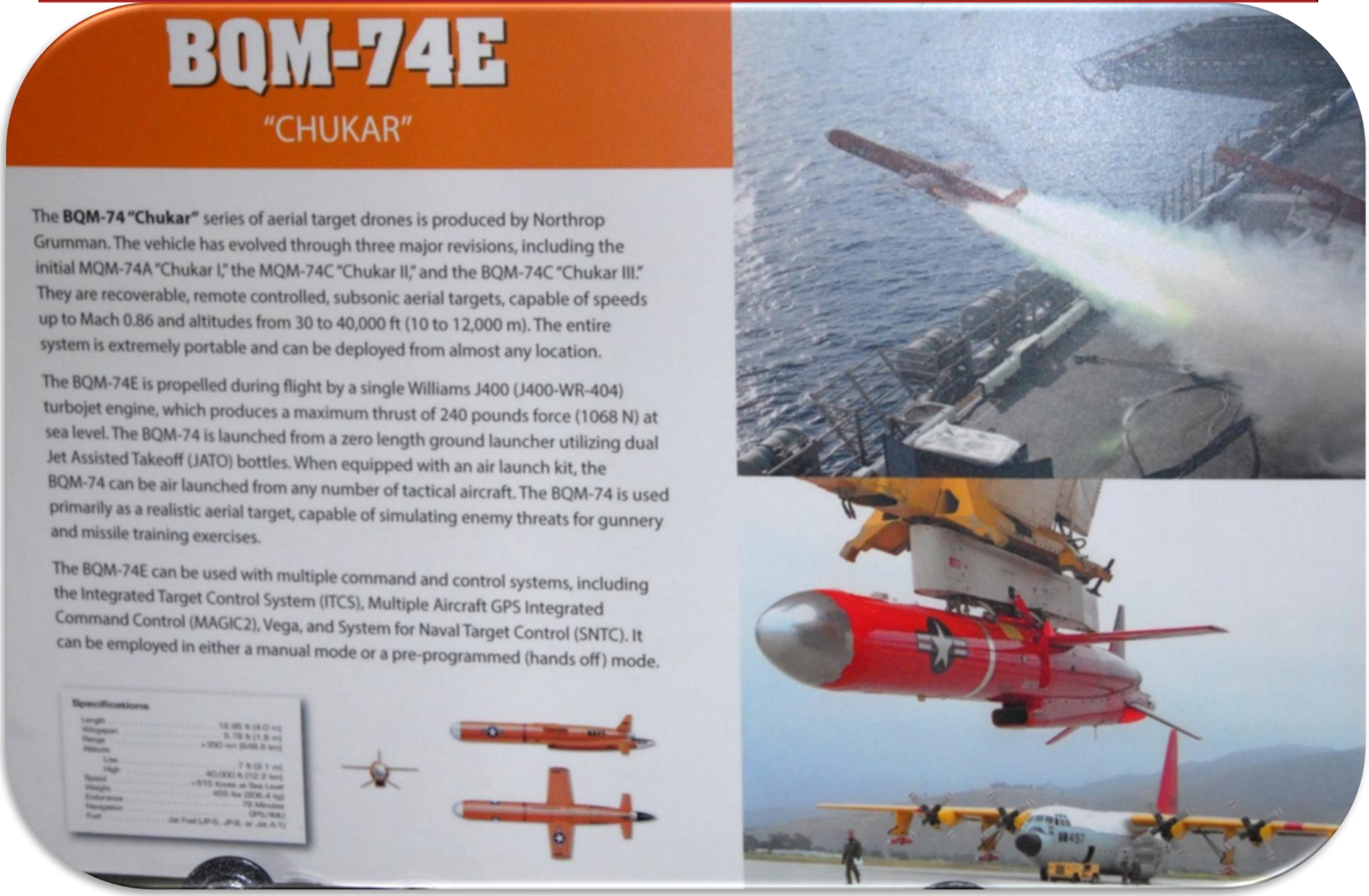

BQM-74E

"CHUKAR"

The **BQM-74 "Chukar"** series of aerial target drones is produced by Northrop Grumman. The vehicle has evolved through three major revisions, including the initial MQM-74A "Chukar I," the MQM-74C "Chukar II," and the BQM-74C "Chukar III." They are recoverable, remote controlled, subsonic aerial targets, capable of speeds up to Mach 0.86 and altitudes from 30 to 40,000 ft (10 to 12,000 m). The entire system is extremely portable and can be deployed from almost any location.

The BQM-74E is propelled during flight by a single Williams J400 (J400-WR-404) turbojet engine, which produces a maximum thrust of 240 pounds force (1068 N) at sea level. The BQM-74 is launched from a zero length ground launcher utilizing dual Jet Assisted Takeoff (JATO) bottles. When equipped with an air launch kit, the BQM-74 can be air launched from any number of tactical aircraft. The BQM-74 is used primarily as a realistic aerial target, capable of simulating enemy threats for gunnery and missile training exercises.

The BQM-74E can be used with multiple command and control systems, including the Integrated Target Control System (ITCS), Multiple Aircraft GPS Integrated Command Control (MAGIC2), Vega, and System for Naval Target Control (SNTC). It can be employed in either a manual mode or a pre-programmed (hands off) mode.

Specifications

Length	12.85 ft (4.0 m)
Wingspan	5.78 ft (1.8 m)
Range	>350 nm (648.6 km)
Altitude	
Low	7 ft (2.1 m)
High	40,000 ft (12.2 km)
Speed	>515 Knots at Sea Level
Weight	455 lbs (206.4 kg)
Endurance	78 Minutes
Navigation	GPS/IMU
Fuel	Jet Fuel (JP-5, JP-8, or Jet A-1)

The End